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THE REPORTS OF THE ISTHMIAN-CANAL COMMISSION.

By John Geo. Leigh.

By his timely, impartial, and thoughtful contribution to a discussion which has for its sole aim the enlightenment of the public upon one of the most important questions of the day, Mr. Leigh places the whole subject of the route for the isthmian canal before the reader in a manner at once authoritative and convincing; authoritative because based upon the reports of the Commission itself, and convincing because of the clear and logical manner of the presentation.—THE EDITORS.

A BRIEF personal note must of necessity preface this article. It is with very pronounced appreciation of the privilege accorded me that I accept the hospitality of THE ENGINEERING MAGAZINE to participate in a discussion which has done much to enlighten the civilised nations upon certainly the most important material question of the day—whether judged from the standpoint of world-politics, of economics, or of science. The distinction is the more marked because I follow such authorities (to mention but a few) as General Abbot, *facile princeps* in all that relates to hydraulic engineering; Mr. W. Henry Hunter, chief engineer of the Manchester Ship Canal; Mr. Charles Paine, past president of the American Society of Civil Engineers, and Professor Lewis M. Haupt, of whom it is only necessary to remark that he has served upon the two latest and most important of isthmian canal commissions. My position in relation to the question is peculiar, perhaps unique, for although I have devoted to the subject many years of careful study, I am absolutely without concern, present or potential, in the adoption of any route. I am not even engaged in engineering work, nor am I associated, however remotely, with any of the powerful interests—shipping, commercial, or insurance—so closely identified with the

future of the enterprise. I write as a well-wisher of the great American nation, profoundly grateful for what it has achieved, and is yet destined to accomplish, in the service of mankind; and I take up my pen today the more readily because I regard the present as a critical juncture in the history of what should be a beneficent undertaking, fulfraught with glory and preferment to the United States, and of advantage to all the world. Than the isthmian canal there is no movement with which I have larger sympathy, and I very devoutly hope that my words may have influence for good.

Thanks to faulty wording of the acts of appointment or to niggardly appropriations, Congress may be held responsible in greater or less degree for the comparative failure of some of the early canal commissions, boards, and surveys. No such plea, however, can be urged in connection with the existing deadlock, for which, it seems to me, the Isthmian Canal Commission is very largely, if not wholly, to blame. The Commission was never asked, directly or indirectly, to "recommend" a particular route, nor was it inconveniently hampered (except possibly from within) by the self-evident proposition that any canal constructed by the United States must necessarily be placed under the latter's control, management, and ownership. The main and most important object of its appointment was to accumulate for the guidance of the Executive and Congress full and reliable information on a given number of points—a very honourable and, in my opinion, sufficiently onerous task for any body of men, however numerous or distinguished. The Commission was, however, in no sense restricted as to the scope of its investigations or the presentment of its views. "You will be guided," wrote Mr. Secretary Hay to Rear-Admiral Walker on June 10, 1899, "by the provisions of the act of Congress," but "your duties will not be limited by the terms of the act, and if any line of inquiry should suggest itself to you in the course of your work as being of interest or benefit, I am confident you will not fail to give it whatever attention it may seem to deserve. The President trusts that the Commission will fulfil the important duties confided to them in such a manner that when their report is prepared, it will embrace all the elements required for his own guidance and for the final action of Congress."

The Commission, therefore, would have been not only justified, but quite in order, had it differentiated its findings from various points of view—for example, technical, financial and political. Had this been done—it would have been at once the most easy and straightforward course—the Commission might have recorded facts as they

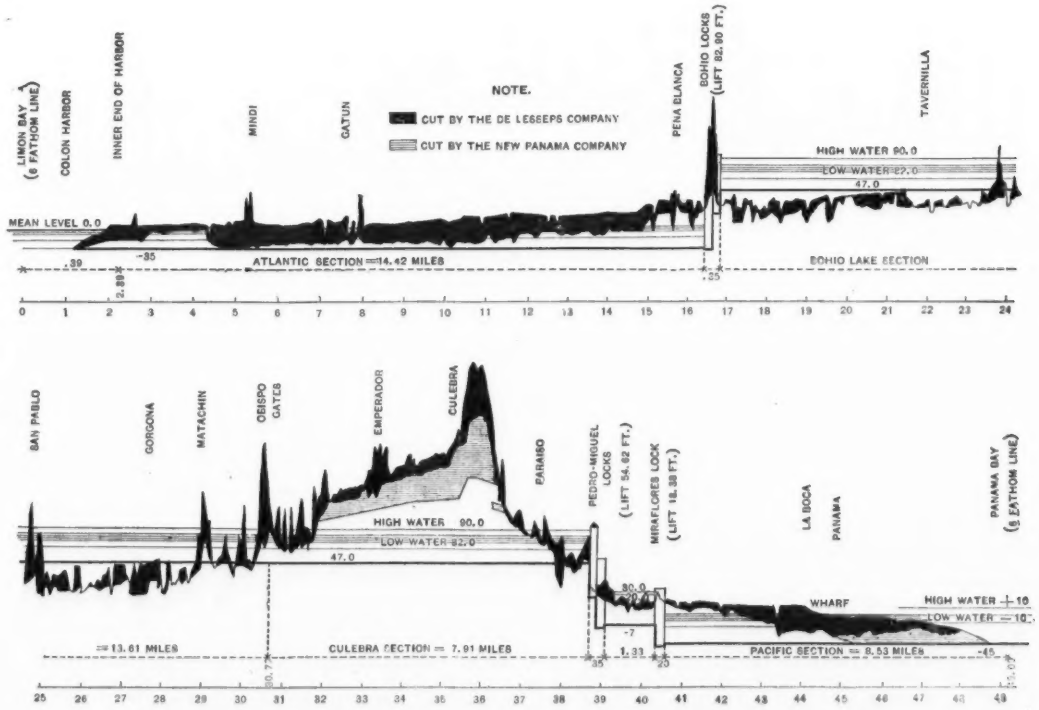
were, not as it wished them to appear; might have stated plainly what it longtime only ventured to suggest; and would most certainly have earned for itself the confidence of the nation, instead of exciting doubts as to its own singleness of purpose. Throughout the reports, preliminary and "final," three facts stand out in high relief:—(1) an enforced avowal that the completion of the Panama enterprise must necessarily be more feasible and less costly than the construction of any other inter-oceanic canal; (2) an amiable predisposition to speak well of each of the rival schemes adopted by the Commission, the one from the Nicaragua Canal Commission, the other from the International Technical Committee; and (3) a strained endeavour to justify, against the ill-disguised preferences for Panama, the following remarkable and, in my opinion, quite uncalled-for peroration—that " 'the most practicable and feasible route' for an isthmian canal, to be 'under the control, management and ownership of the United States,' is that known as the Nicaragua route."

I have welcomed as a logical and courageous act the Commission's recent reversal of its original vote. This, however, does not in any degree involve a restoration of faith in the accuracy of the Commission's reports. In the document transmitted to Congress in December last, the Commission placed on record a number of facts and figures, interesting and valuable from many points of view, but certainly not above reproach when applied, as was their prime purpose, to a comparison of the Panama and Nicaragua projects. Truth to tell, no fair comparison is possible on the bases, practically identical in each case, suggested by the Commission; and the more the report is considered, the more manifest must this fact appear. The Commission inherited from its predecessor, the Nicaragua Canal Commission, a scale of unit prices, intended originally for exclusive use in connection with Nicaragua estimates. In 1899, however, this scale, with a few insignificant changes, was adopted as a basis common to both canals, no discrimination whatever being exercised in connection with the very different conditions under which work would be conducted along the two routes. Some suspicion of the unfairness and futility of such a proceeding appears to have dawned upon the Commission during the drafting of the final chapters of its report, for on page 256 we may read a laboured attempt to argue that the relative magnitude of the two enterprises may best be measured by the total estimated cost of construction, not by length and other physical conditions! In other words, we are asked to believe that $5,630,704—the difference of cost, as estimated by the Commission, of acquiring and

completing the Panama Canal and building, in very unpromising virgin soil, a navigable channel between Greytown and Brito—"measures the difference in the magnitude of the obstacles to be overcome in the actual construction of the two canals and covers all physical considerations, such as the greater or less height of dams, the greater or less depth of cuts, the presence or absence of natural harbors, the presence or absence of a railroad, and the amount of work remaining to be done.

Not $5,630,704, but at least ten, and possibly twenty, times that amount, represents the difference of expenditure needful in Nicaragua on account of excavation alone! It is admitted by the Commission that the aggregate excavation required in connection with the Panama enterprise cannot, under any circumstances, exceed 100,000,000 cubic yards, of which 43,237,200 cubic yards will be concentrated in the 7.91 miles between the Obispo gates and Pedro Miguel locks. On the other hand, the adoption of the Nicaragua route would involve 190,000,000 cubic yards of earth and rock excavation, of which 10 per cent. only would be centralised in the cut through the western divide, the remainder being spread over practically the entire length of route.

Instances without number could be quoted for the purpose of showing how sophistical are the figures which we have been asked to accept as reliable "estimates" for the construction of a Nicaragua canal. I will content myself, however, with a single example, certainly not the most glaring which might be cited. I have noted with interest the proposed expenditure, under the head of "Harbors," for Panama and Nicaragua respectively. Although there already exists at each terminal of the Panama Canal a more or less commodious harbor, the Commission has estimated that there should be expended in improving the entrance and harbour at Colon no less a sum than $8,057,707, of which $1,936,991 would be devoted to work outside the jetty, and that for dredging the channel outside the Panama Railroad Company's wharf at La Boca a further amount of $1,464,513 should be appropriated. All money spent in improving natural harbours, for which there is always need, is, in my opinion, well-invested, and I consequently take no exception to either of the above estimates, although that for Colon certainly appears excessive. What, however, is to be said of them in comparison with the expenditures proposed by the Commission for creating at the two ends of the Nicaragua route entirely new harbours? For the harbour, entrance, and single jetty planned at Brito, the Commission puts forward an estimate of $1,509,470, and for the very troublesome work anticipated at Greytown

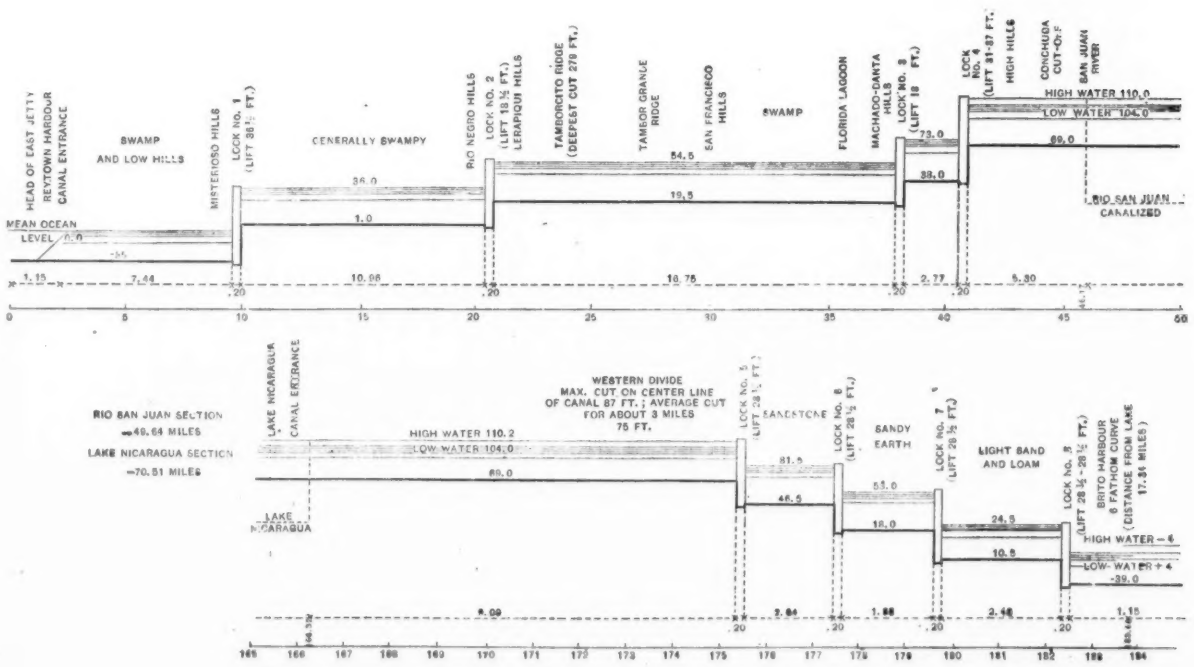


PROFILE OF THE PANAMA CANAL. PROJECT RECOMMENDED BY THE ISTHMIAN CANAL COMMISSION.

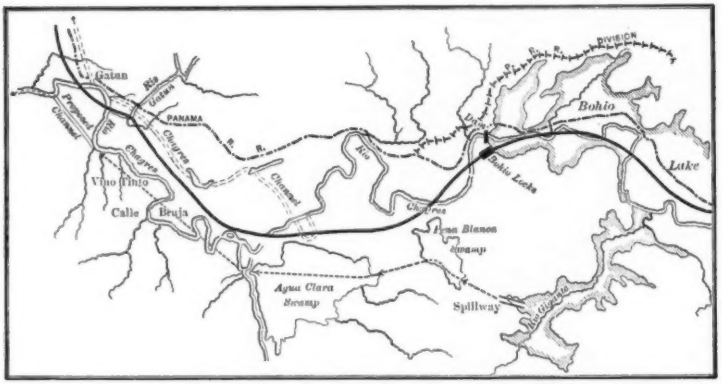
contents itself with a modest provision of $2,198,860. The problem at Greytown is admitted to be one of the most serious difficulties of the Nicaragua project; the Commission anticipates that quite two years will be required to make the necessary preparations and to construct an entrance and working harbour having a depth of 15 feet, and further that to maintain a depth of 35 feet, more or less constant dredging, costing $100,000 annually, will be essential. Nevertheless, the entire capital charges on account of this great undertaking are estimated at only 50 per cent. more than the expense of dredging the already navigable channel between Perico Island and La Boca wharf!

Among the illustrations to the present article will be found a longitudinal section of the Panama Canal, showing the plan for completion recommended by the second Walker Commission. In it I have also endeavored to indicate, as accurately as the limited size of the drawing would permit, the amount of excavation work already done, *i. e.*, 36,689,966 cubic yards, which the Commission regards as of value under its plan, and that (about two and a half times the quantity mentioned) which remains to be accomplished. The comparison appears to me interesting, as evidence of the present forward condition of the works and the not extravagant estimate of their monetary value framed by the American Commissioners.

It is to the lasting discredit of Ferdinand de Lesseps and his engineer coadjutors that, although they planned a sea-level canal, they never very seriously considered the necessity of protecting the latter and of assuring the safety of navigation against the violent floods through which they proposed their enterprise should pass. Yet it must have been obvious, even to them, that the lower the level the more pronounced would be the dangers, and that such expedients as they proposed were either absurdly inept or calculated to increase rather than modify the ever-present menace to the works. It was practically left to the International Technical Committee of 1896-98 to devise a comprehensive and efficient scheme for the control, and indeed utilisation, of the inconstant Chagres—the vital problem, more important by far than the great cutting through the Cordilleras, which called for complete solution before any ship-canal between Colon and Panama should ever have been attempted. The best of engineers is but a child when pitted against the forces of nature; he can conciliate them to his great advantage, but never defy them, and in frank recognition of this fact will be found the inherent strength of the Panama enterprise, as now understood.



PROFILE OF THE PROJECTED NICARAGUA CANAL—ATLANTIC AND PACIFIC SECTIONS.



PANAMA CANAL. DISPOSAL OF FLOOD WATERS.

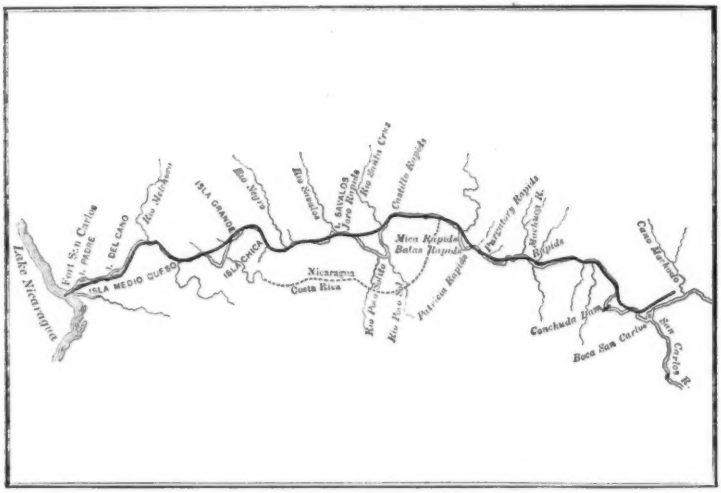
The scheme of the *Comité Technique* has been so frequently and fully described in the pages of this Review that there exists no necessity for lengthened allusion to it. With some modifications, it has been adopted by the Isthmian Canal Commission as the best possible plan applicable to the circumstances; and its promise of security is materially strengthened by alliance with a summit-level longer than appeared in the Technical Committee's high-level project and more elevated than that for which the same body avowed a preference. The members of the United States Commission very properly claim that simplicity is the marked feature of their plan, and I very cordially endorse that description without, however, for a moment admitting that the original was intricate. By the convenient, if costly, expedient of raising the height of the Bohio dam, the depth and area of the so-called Bohio Lake section will be so increased that the full flood discharge of the Rio Chagres may be received into it without the least risk of impeding navigation; and at the same time it will be possible to utilise to the best advantage the very favourable topographical conditions for the discharge of all waters in excess of canal requirements. The proposed dam at Alhajuela, on the upper Chagres, is, of course, no longer an indispensable adjunct to the system of flood control; but I am much inclined to think that its retention in the plan, for the purpose of moderating the more violent floods from the upper river, would be well-worth its additional cost.

Excepting the Bohio dam—a work of considerable magnitude and presenting many difficult features—the locks, the Obispo guard gates, and a spillway to regulate the height of the Pedro Miguel-Miraflores

level, no important structures are called for on the Panama line. Away from it, however, are some subsidiary works, neither complex nor costly, which will prove of great utility to the efficient administration of the canal. They are designed as adjuncts to the automatic regulation of Lake Bohio, and appear no less practicable than simple. The water from the lake, after passing over the Gigante spillway, will flow across country about a mile to the Pena Blanca swamp, which is separated from the canal line by a sufficiently high bridge, and will thence be discharged, by an artificial channel, into the less elevated and larger morass of Agua Clara. Further on are other swamps, well-removed from the line of the canal and affording a wide area for the spread of flood waters, until the neighbourhood of Gatun is reached, and thence an artificial channel will be cut to the Chagres, through which the overflow from Lake Bohio and all tributaries below the lake on the west side of the canal will find its way to the sea. It should be added that for about five miles in the low-lying region about Gatun, the canal will require to be protected from overflow by levees. On the east side, for the purpose of diverting the Rio Gatuncillo, the channel built by the original French company as a Chagres diversion will be put into service.

It is but just, before referring to the Nicaragua project, that I should bear testimony to the admirable clearness with which the Isthmian Canal Commission has explained its salient features. At the same time I cannot but express serious doubts as to the adequacy of attention devoted not only to the great but also many of the minor problems of the route.

I much doubt if I exaggerate the difficulties which have to be encountered during the first twenty miles or so after leaving Greytown when I say that, excepting the heavy work in the Culebra section and the construction of the Bohio dam, the entire Panama canal might be built more easily and at no greater cost. For many miles of the distance mentioned, the Nicaragua canal line passes through a flat and swampy country, where the rainfall is abnormally heavy and practically continuous. The swamps communicate freely with the rivers in the neighbourhood, the flood levels frequently rise many feet above the level of the Caribbean Sea, and embankments will be required for long distances, not only to maintain the canal from within but also to exclude flood waters. The soil, moreover, is often so unsuitable even for the roughest of embankments that clay for their construction will have to be brought from the adjacent hills. At least two rivers will have to be diverted, and four wasteways are planned, each neces-



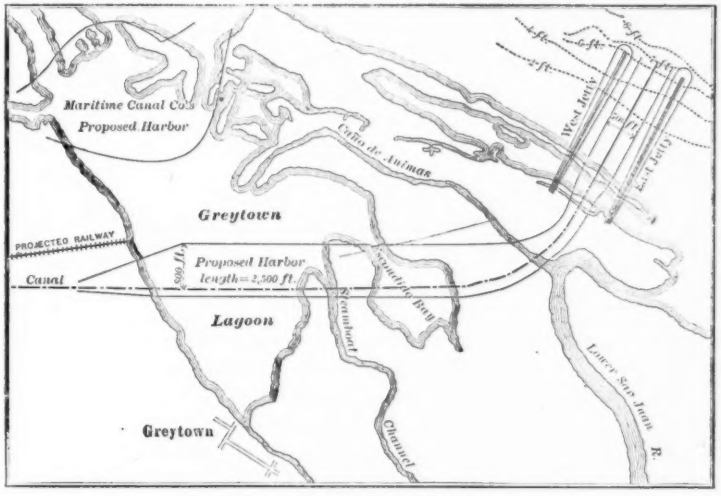
NICARAGUA CANAL. THE SAN JUAN RIVER CANALIZED.

sarily at a considerable distance from the canal line, for the purpose of protecting it from floods. It is not until Lock No. 4 is reached that these treacherous swamps can be eluded. Westward from Lock No. 2 are heavy cuttings through the Tamborcito, Tambor Grande, and San Francisco ridges, consisting largely of hard, basaltic rock; across Embankment Creek and the Machado River embankments will be required, for which considerable excavation will be needed, so that they may rest on firmer material than swamp; and beyond Lock No. 4 is a rough and hilly district where much deep cutting, through rock and clay, will be encountered. The total distance from the inner end of Greytown harbour to the junction with the San Juan river is 44 miles, and the estimated cost of constructing a canal across it—exclusive of the $19,258,572 allowed for the locks and their excavation—is $43,574,044. This sounds a large amount, but I venture to think that for this section of the work an appropriation at least 50 per cent. larger would not be by any means excessive.

West of the Lake, the soil is invariably harder, and consequently more suited for canal construction; its adamantine virtues, indeed, are so pronounced that the necessary excavations are likely to prove unusually costly. The estimates of the Commission provide for a number of subsidiary works, including diversions of the Rios Grande and Las Lajas, a dam near Lock No. 5 to maintain the summit level,

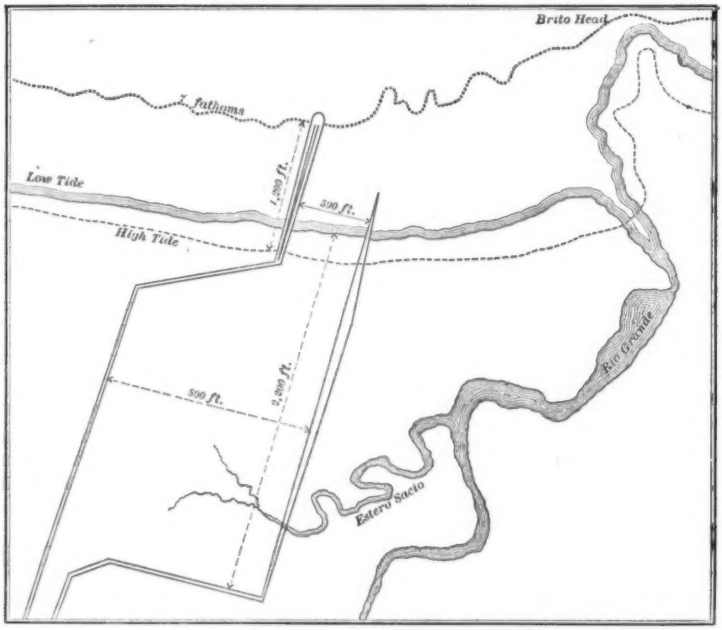
waste-ways, embankments, and the like, none, however, of very serious moment or involving difficult engineering.

The crux of the Nicaragua project is, of course, the regulation of the Lake level, a subject which had been almost studiously avoided prior to the labours of the Nicaragua Canal Commission. It would be unwise, in the limited space at my disposal, to attempt either a description or criticism of the scheme formulated by this body and adopted by its successor. The plan appears feasible and to be founded upon careful hydrographical observations, but all the data needful to make it even theoretically perfect are admittedly not yet to hand.



PROPOSED HARBOR AT GREYTOWN.

The sites of the proposed Conchuda dam and auxiliary waste-way seem to be most happily chosen, and the plans for these structures also appear in every respect satisfactory. Speaking generally, I do not hesitate to describe as most important and valuable that portion of the report of November last which deals with the problem of Lake regulation. There is, however, one very important point in connection therewith which appears to demand immediate explanation, and this I will endeavor briefly to express. For the purpose of regulating the Lake or summit level, the latter is to be extended for 55 miles to Lock No. 4, and to the Conchuda dam 3.3 miles down stream from the point where the canal leaves this arm of the Lake. There are, however, notable slopes in the various reaches of the River San Juan



THE PROPOSED HARBOUR AT BRITO.

which it is proposed to canalise; for instance, with the Lake at elevation 104, the fall in feet to the head of the Toro Rapids is 5.4, in the Toro Rapids the fall is 7.3, from the foot of these rapids to the foot of the Castillo Rapids 7.2, and thence to the foot of the Machuca Rapids 28.5. The surface level of the canal, therefore, at the last mentioned point would be 48.4 feet above the bed of the river under normal conditions, a circumstance which has raised in my mind the following question, not determinable by the reports of either the Nicaragua or Isthmian Canal Commissions, namely:—is the river so hemmed in on each side by high ground that no embankments will be needed to sustain the proposed canal?

It may be that this and all other questions of construction can be answered to the complete satisfaction of advocates of the Nicaragua project. Construction and relative cost, however, are not the only and most important points in the controversy; they are quite inconsiderable as compared with the questions of operation and serviceableness. As regards the first, the Isthmian Canal Commission offers

us the not impressive information that it has estimated the annual cost of maintaining and operating the Panama Canal at $2,000,000, as against $3,300,000, the corresponding charges for Nicaragua. It has arrived at these figures by the comfortable, but certainly very inadequate, expedient of a percentage of the cost of construction, and the same rule has served it in connection with certain capital charges, ingeniously massed as "engineering, police, sanitation, and general contingencies." On account of these the Commission has added to the estimated cost of constructing the Nicaragua Canal and its railways, harbours, and other works, a sum of $31,644,090, or 20 per cent.; but for some occult and unexplained reason, in the case of Panama, the percentage is calculated only on the estimated cost of completion, without adding thereto any amount representing the work already accomplished. Estimates and their proper presentment are obviously weak points with the Commission; otherwise I should be tempted to ask why "police" and "sanitation" appear only as capital charges, and are quite ignored as items of general supervision.

It is proposed, and very properly so, to improve the course of the canalised San Juan by various cuts-off. These suggested rectifications of the channel are neither few nor far between, but it is very doubtful, even with their introduction, if this section of the route will commend itself to the shipping and insurance interests. Despite the improvements of the Isthmian Canal Commission, one half of this section still remains in curvature, four of the curves having radii of 6,876 feet, two of 5,927, six of 5,730, three of 5,289, two of 4,911 and four of 4,045! Curvature, as a matter of fact, is one of the weakest points of the Nicaragua route, as compared with Panama, or, indeed, any channel intended for use by large ocean-going steamers, and it seems very doubtful if further improvement is possible, except at almost prohibitive cost. On the other hand, the alignment of the Panama Canal is exceptionally good; twenty-one of the curves have radii ranging from 9,842 to 19,629 feet, four have radii of 8,202 feet, and three only fall below the limit of 6,500 feet. The following sum up the respective merits and demerits of the two canal lines in the matter of curvature:

	No. of Curves.	Length—Miles.	Total degrees of curve. °	′	″
Nicaragua	56	49.29	2,339	50	30
Panama	29	22.85	771	39	00

"The completion of the harbours as planned for both routes would yield but little advantage to either, but the balance of advantages, including those of maintenance and operation, is probably in favor of

the Panama route." Thus wrote the Isthmian Canal Commission, in November last, concerning a matter which even the most enthusiastic supporters of the Nicaragua route regard with disquietude. The Commission is entitled to considerable credit, no doubt, for having planned, out of most unpromising material, harbours at Greytown and Brito; but the best of plans and the most sublime faith in their excellence will not, of themselves, construct and keep open harbours, especially where, as at Greytown, the forces of nature have united in ceaseless war against such an enterprise. By means of the proposed east jetty at Greytown, the westerly drift of sand may for a time be checked, and for quite a considerable period perhaps dredging may keep the entrance clear. How long the battle will last it is of course impossible to say, but the history of engineering is prolific of warnings as to its only too probable issue.

That a ship canal, of a sort, can be built over the Nicaragua route, I do not for a moment doubt; but I do very seriously question the possibility of constructing—within reasonable limits of time and expenditure—a water-way likely to be of service to the navy and commerce of the United States, to say nothing of those of other nations. Formerly, when many false impressions prevailed concerning the topography of the route and the advantages accruing from the presence of Lake Nicaragua and the river San Juan, some apologies could be offered for persistent advocacy of this route. Within recent days, however, the conditions of the controversy have vastly changed, and I, for one, fail to appreciate the "patriotism" which insists that it is the duty of the United States irrevocably to identify themselves with an adventure of dubious wisdom and utility, for no better reason than that in times past there existed many erroneous views upon the subject. The people of the Union will fall immeasurably in the opinion of all far-sighted and friendly nations, and prove false to every ideal in their history which has made them the industrial pioneers of the world, if now, standing at the parting of the ways, they choose the crooked path. The one road is full of promise of a triumphant realisation of perhaps the most grandiose enterprise ever planned by man; the other is abundant in menace to the national influence, prestige, and pride, and certain to engulf to no useful end many millions of well-earned dollars. I cannot believe that a practical, educated, progressive, and heretofore level-headed people will permit themselves longer to be blinded to a true appreciation of facts and all that the latter portend.

MONEY MAKING MANAGEMENT FOR WORKSHOP AND FACTORY.

By Charles U. Carpenter.

III.—THE ELEMENTS OF A WORKING SYSTEM.

In his first and second papers Mr. Carpenter dealt with the general principles of factory organization, and with a description of a remarkable example of a highly organized establishment. Before taking up each department of work in detail, he now briefly discusses the nature of these subdivisions, preparing the reader for the very full examination of each of these sections in the following articles. In this connection attention is called to the papers by Mr. Falconer upon the Factory Office, the first of which appears elsewhere in this issue. —The Editors.

THE struggle for commercial supremacy in this day of competition has forced upon the attention of the business world the all-important fact that in the adoption of up-to-date, efficient factory systems lie great possibilities of economies and a better product at lessened cost.

In seeking the reason for the lasting and commanding success of American business organizations of today, two facts will stand out prominently. One is that the organizations are founded upon principles that are in accord with modern progressive ideas and that tend to bring out the latent intelligence, loyalty and strength of all its members.

The other is that the important details of factory work are cared for by systems which are homogeneous, flexible and efficient; systems which leave nothing to chance, but which care for the smallest and the most important details of factory work alike.

The most effective means of increasing the volume of any business is the organization of the advertising and selling forces upon modern lines. The strongest support for the selling force and the best bulwark against competition is thorough organization of methods of production. Organization that will give new products, improvements of old products, more prompt deliveries and lower costs.

In the mind of the old-time manufacturer the word "system" is indissolubly linked with that horror of "extra clerks." It is the old question of the man holding the coin so close to the eye as to shut out entirely the greater and broader horizon of his commercial possibilities in both the expansion of his business and in factory economies.

He does not understand that the losses he is daily bearing are many times the amount that his extra clerks would cost him. In fact, his "extra clerks" would probably prove the best investment he could ever make. Many a man will place all conceivable safe-guards around his systems for handling and caring for his money and yet will be altogether careless of the manner in which his valuable stock, purchased by his money, is handled. Experience has shown that the opportunities for losses in the manufacturing end of the business are often as large as on the commercial side, and that the opportunities for economies in the former are often much greater than in the latter.

On a par with this old-time manufacturer with his horror of expenditure for clerical work, is that other unprogressive individual who says "Oh, that is too much red-tape for me. When I or my men want a thing we go get it in the quickest and easiest way we can. No red-tape, no records for me. Every one helps himself, and we get out the work somehow." The results are what might be expected. His "somehow" product is generally not good in quality, not delivered promptly, nor sufficiently low in cost to enable him to hold his own in the business world. A manufacturer ought to realize that he should be guided in his system of factory management by the same principles that he uses in checking up his bank account, seeing that he is credited with all deposits, and debited only with that which is properly chargeable to him, by the same common-sense that he uses in keeping the proper trace of his accounts. A man is showing the same lack of business judgment in refusing to admit the necessity for practical factory systems and a proper series of factory records, as he would were he to discard his book-keeping and trust to luck to come out "somehow" in his accounts. The "red-tape" is but common-sense applied to factory management. The writer is not a believer in "red-tape," but does insist that a proper regard for a few principles is absolutely necessary for the successful factory management.

It would be profitable to any manufacturer to consider seriously how far his systems are from being as efficient as they should be. This was taken up at some length in my former article and its great importance dwelt upon fully.

We hear much today about American products standing at the head in the markets of the world because of her automatic machinery and intelligent workmen. While this is true, still the writer asserts that investigation will show that, in the case of a vast majority of such products, the factories producing them are organized on modern lines. They know what their product costs them. It is produced without

any unnecessary handling or expense, and every device of system and machinery is adopted to perfect their organization and product. It behooves the manufacturer of today to "look to his corners" and perfect his organization at every possible point or he will be left behind by a better organized competitor.

Factory Systems. The writer presents a series of systems which have proven to be of great efficiency and at the same time comparatively inexpensive. All "red-tape" is done away with, but the few fundamental principles and rules laid down must be followed out with uncompromising firmness. If these are properly adhered to and developed the important results herein outlined will be produced.

First, stock and stock tracing. A complete system should reduce the investment in stock and machinery to as low a point as possible and provide against all delays in the delivery of finished parts to assemblers, or finishers. This should be accomplished with a minimum of expense.

Second, costs. Providing accurate tabulated records of all costs, both of separate parts and of the finished product so as to form valuable records whereby the possibility of economies can be detected and the selling price fixed with exactitude.

Third, machining or producing. The product must be produced in the best manner possible at the lowest possible cost. It should be so finished in the main machining or producing departments as to eliminate all fitting, filing, or finishing in the assembling or finishing departments. The use of improved automatic and multiple machinery, jigs and gauges, should prevail to the greatest possible extent to insure uniform, interchangeable and a cheapened product.

Fourth, inspection. Probably no one of the highly important details of the factory systems is more neglected than this one. Inspection is absolutely necessary in order to secure the results above mentioned. It is also the only method by which proper check on the quality of the work can be secured and give assurance that the men will get paid only for that which is of the proper quality.

Fifth, scrappage. An inexpensive system can be devised that will prevent reckless extravagance in stock. The product handled by this system can be sold at a much higher price.

Sixth, piece-work. The great economies secured by proper system of piece-work are well understood. The system, however, should provide accurate checks on the workmen. In addition to the piece-work, records of the earnings and output of each man will be found to be very valuable.

Seventh, tools. Tool designing, methods of tool supply and tool making are of vital importance. The methods of up-to-date organizations can be suggested which will largely increase the output of the ordinary tool room.

Eighth, inventions. The progressive spirit of any firm may be gauged by its systems of inventing and designing new product for the market. This feature, often neglected, is of the highest importance for the future of any concern. Careful consideration should be given to the methods of securing ideas and of developing them; also, the thorough testing of new inventions before the tools are made and the product placed upon the market.

Naturally, the proof of any system is the manner in which it operates under severe conditions. A former article described fully the output and factory conditions of the National Cash Register Company where these ideas have been carried out to the fullest extent. Some of the most important of these data are here given to illustrate how severe these conditions are under which such a system has been developed. In the stock rooms are carried over 13,000 different kinds of stock; the stock tracer is continually handling over 19,000 different orders for stock, consisting of over thirty-million pieces. In one year the inspection and stock tracing department handled over two hundred million (200,000,000) pieces of stock. The piece-work system takes care of over 22,000 piece-work prices. Notwithstanding the fact that the machine room capacity is limited and great accuracy in the stock is required, no delays in the output, nor any difficulty in assembling are experienced.

Written orders. One rule in particular is necessary for any system. That is, *all orders must be in writing.* This must be adhered to strictly. Written orders are necessary for a number of reasons. First, they reduce the liability of error and misunderstanding to a minimum; second, they fix absolutely the responsibility of all acts upon those to whom it belongs; third, they promote accuracy and care in the preparation of orders. One factory has adopted an admirable plan to impress this rule upon the minds of all. Upon the stationery used throughout the factory are printed the words *"Verbal orders don't go."*

Having thus outlined the departmental subdivision of the factory system, as organized for money-making operation, the next article will take up the subject of stock and stock-tracing in detail.

MODERN PRACTICE IN BOILER-MAKING SHOPS.

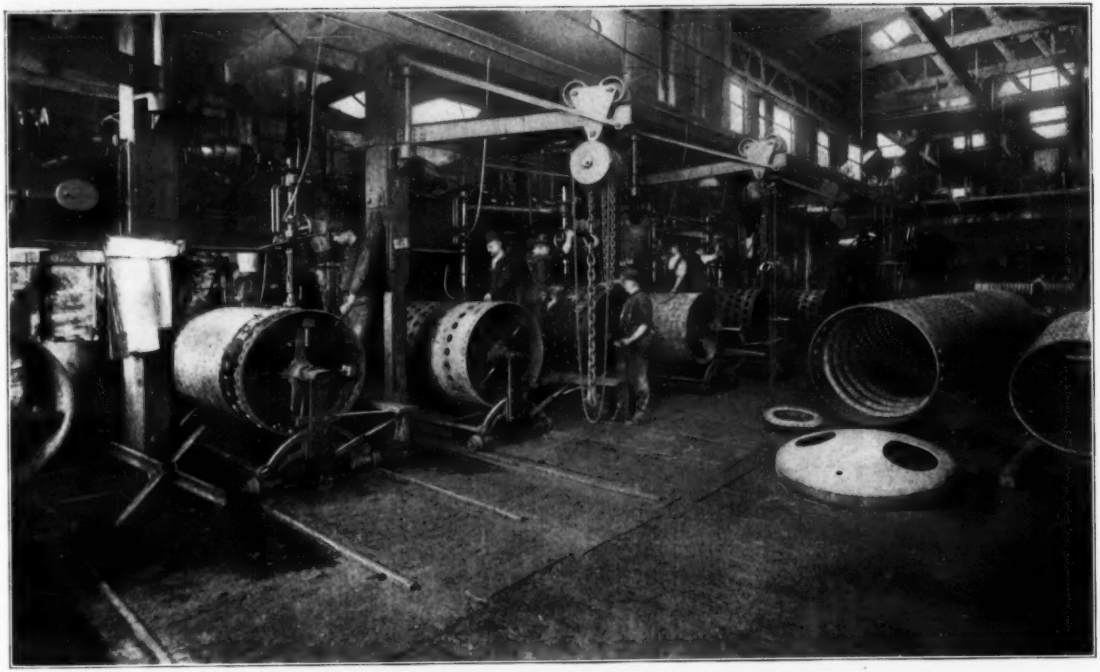
By Egbert P. Watson.

The transformation in the equipment of manufacturing establishments, concerning which much has been said in these pages already, has not been limited to the machine shop; the boiler-making department has also shared in it. Mr. Watson tells, out of his ripe experience, the transformation which has taken place in his own times, and the numerous illustrations show the extent to which both Europe and America have shared in this work.—THE EDITORS.

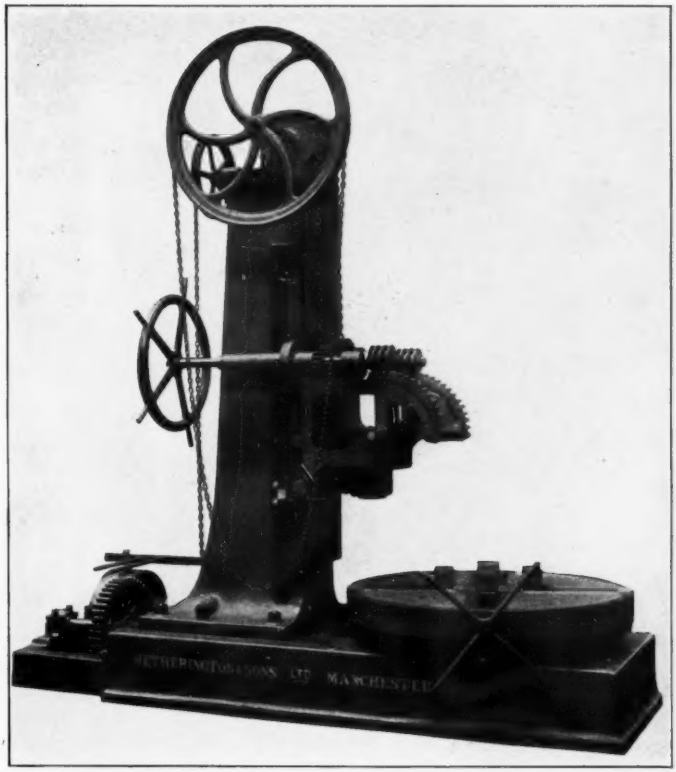
IT is not necessary to look back more than few years to recall the time when a steam boiler was made of almost "any old stuff," riveted up somehow, anyhow, so long as the rivets were spaced with apparent regularity and had good big heads on them The chipping and caulking made the thin sheets look about an eighth of an inch thicker than they actually were, and the fittings and mountings of cast iron were so lavish in material that the buyer felt he was getting a good deal for his money. No one could see inside on the seams, even if it had occurred to him to look there, and discover the mischief wrought by drift-pins urged by heavy flogging hammers upon recalcitrant rivet-holes that simply would not let the rivets in, or find the liners and "dutchmen" that filled gaps where the plates would not come together; but all of these defects existed in cheap boilers, made to sell.

There were good boilers made in old times, be it understood; not all of them were of the class described above, but many were, chiefly those made for a small price. If they were reasonably steam-and-water-tight when done, that was all that was expected of them. If they were the reverse, a wheelbarrow load of manure helped them a good deal.

I will say here that there is no such thing as a cheap steam boiler; boilers are only relatively cheap, as compared with each other. For example, if by reason of larger capital, better shop equipment, and larger facilities generally, a firm of boiler makers should put fifty of one type through their works at once, such boilers could be sold for less than a boiler made to order could be. They are not inferior in quality of metal or workmanship, but they are of the same proportions all through —in grates, heating surface, and tube surface—for a given rating, so that if there is a defect of design the fault is common to all of the fifty, and if a steam user wants or thinks he wants some departures from certain dimensions, he can have them by getting a boiler made to or-



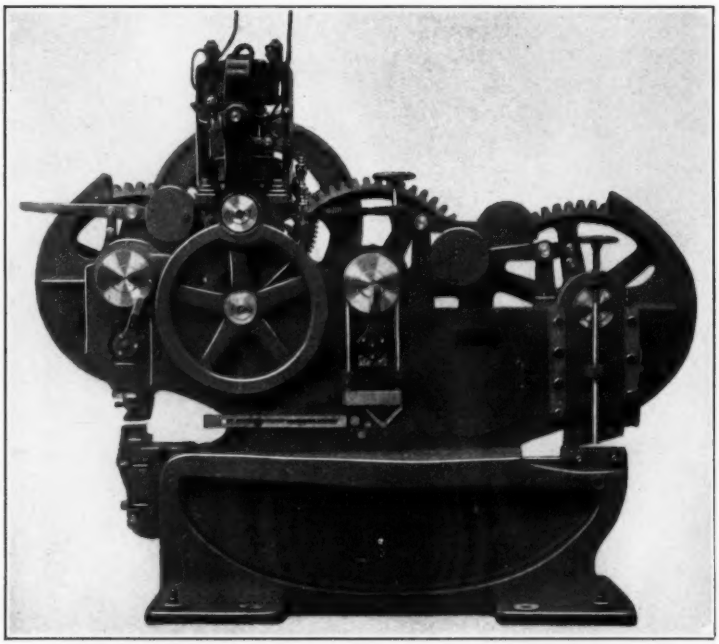
A BOILER-SHOP INTERIOR. CLONBROCK STEAM-BOILER COMPANY.



HEATON'S PATENT FLANGING MACHINE. JOHN HETHERINGTON & SONS, LTD., MANCHESTER.

der. This will necessarily cost more, but it is not relatively more expensive than the boilers built in lots, because the buyer gets (or thinks that he gets) more for his money, which comes to the same thing commercially. But as regards a cheap boiler built for a cheap buyer, the man who purchases it will always regret his want of foresight.

A modern boiler shop is far different from its congener of half a century ago, in that, for one thing, the methods of construction have been greatly simplified and improved tools are in more general use. These last have also reduced costs so much that an old-timer revisiting the shop would stare in amazement at what is now possible. It is not generally known that a boiler of forty horse power can be made and

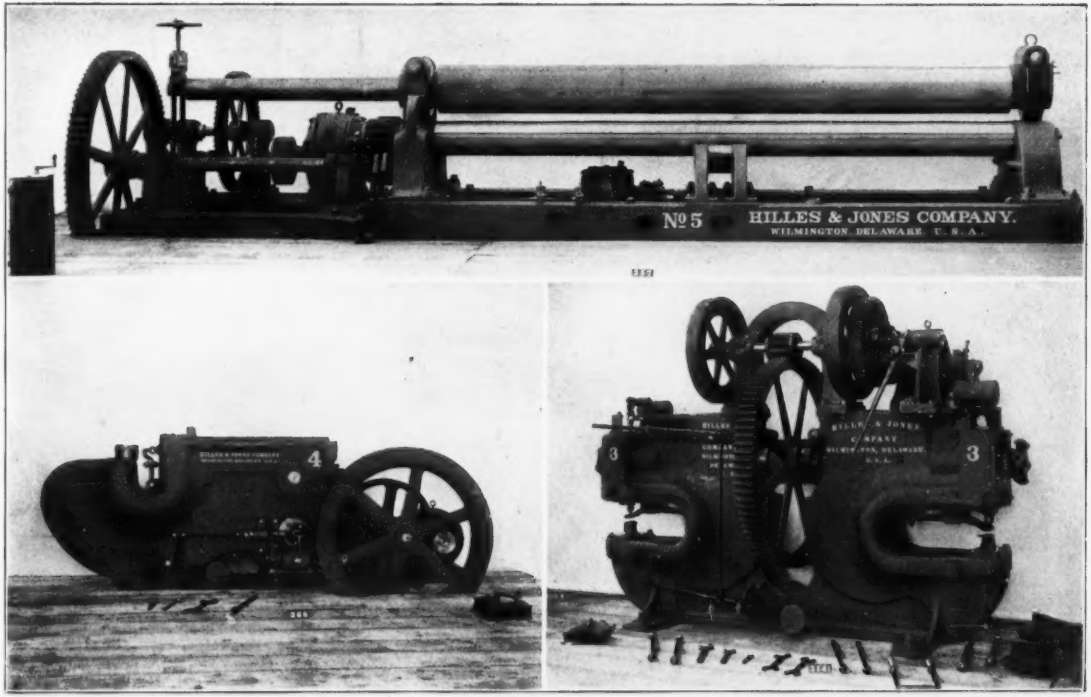


ELECTRICALLY DRIVEN SHEARING MACHINE. R. BECKER & CO., LONDON.

This machine is capable of shearing any length and width of plate, and is combined with a machine for cutting round, tee, or angle iron, and with a punching machine.

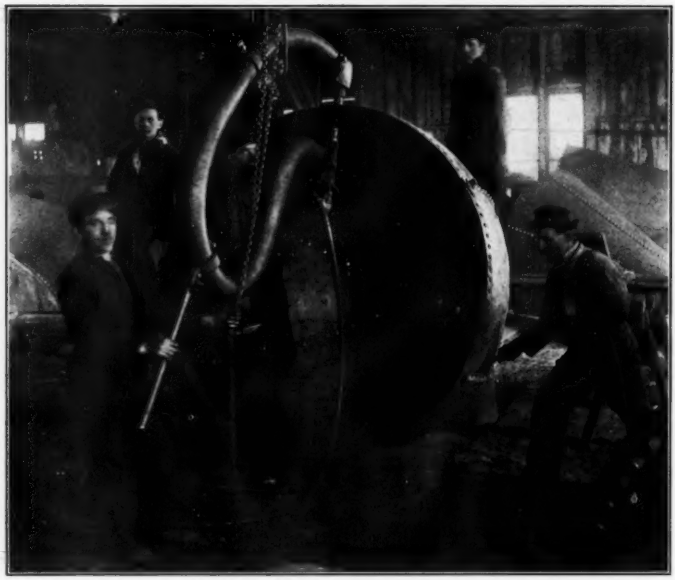
shipped in about eight hours. That is to say, if an order is put in by seven o'clock in the morning it can be on the way to its destination by three o'clock of the same day, ready for steam when set. This boiler will be taken from the flat sheets, rolled to dimensions, all rivets driven, tubes set and rolled, and the work made water and steam-tight within the time named; but it will be of the return-tubular type, where no smith work or flanging is required. This is quick work, and I know of one shop where it is done; doubtless there are others.

The old-time boiler shop which contained nothing but a punching press and a shear in more or less bad condition usually, (as to its blades, certainly,) and a few hand tools, would compare unfavorably with a modern shop of the same capacity, where all rivets are driven by power and seams chipped and caulked by the same agency. To see a little pneumatic machine upon work that will not go under the big machine, closing rivets with only one man at the heading, is itself a revelation.

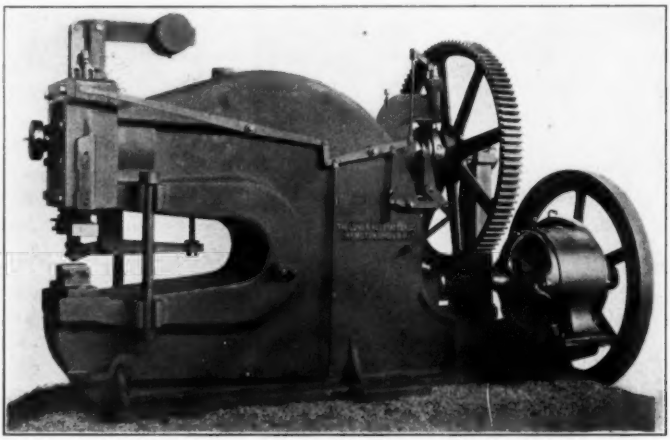


A GROUP OF CHARACTERISTIC BOILER-SHOP TOOLS.

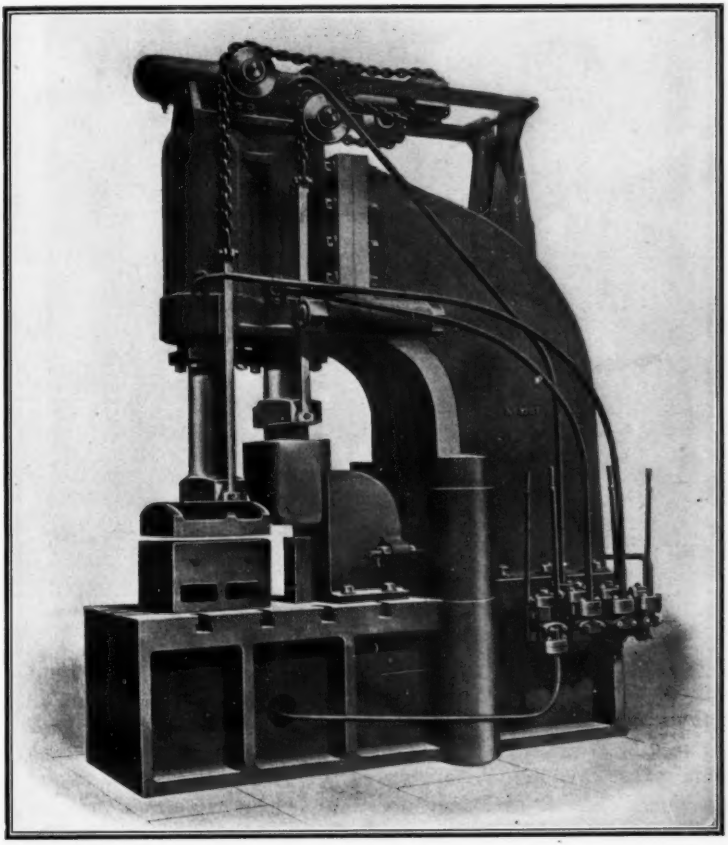
The top view shows an electric-driven plate-bending machine; the motor underneath is used for raising and lowering the top roll, either end being handled independently. Below on the left is a heavy horizontal flange punch, motor driven. On the right is an electric-driven double punching and shearing machine. Hilles & Jones Company.



RIVETING UP BUOYS WITH PORTABLE TYPE PNEUMATIC RIVETER.
Philadelphia Pneumatic Tool Company.



SINGLE BOILER PUNCH WITH DEEP THROAT. ELECTRIC DRIVEN.
Long & Allstatter Company.



PROGRESSIVE BOILER END FLANGING MACHINE. CRAIG & DONALD, LTD., JOHNSTONE.
This machine is also used for flanging flues, steam dome ends, and similar work.

not only of the rapidity, but of the character of the work. All the heads are of the same height and external dimensions if the rivets are of the same length, and they are all "plugged" (that is, the body fills the rivet-hole) and need no caulking. What this means in the cost account no one but the boss boiler-maker who had to pay for handwork can appreciate. Besides the riveting these same pneumatic tools do other work, which when done by the old method was tediously slow. Some chippers and caulkers are quicker than others, but it puts an employer on pins and needles to see a "sojer" laboriously slugging away

FIXED-TYPE RIVETER AT WORK.
Bethlehem Foundry & Machine Company.

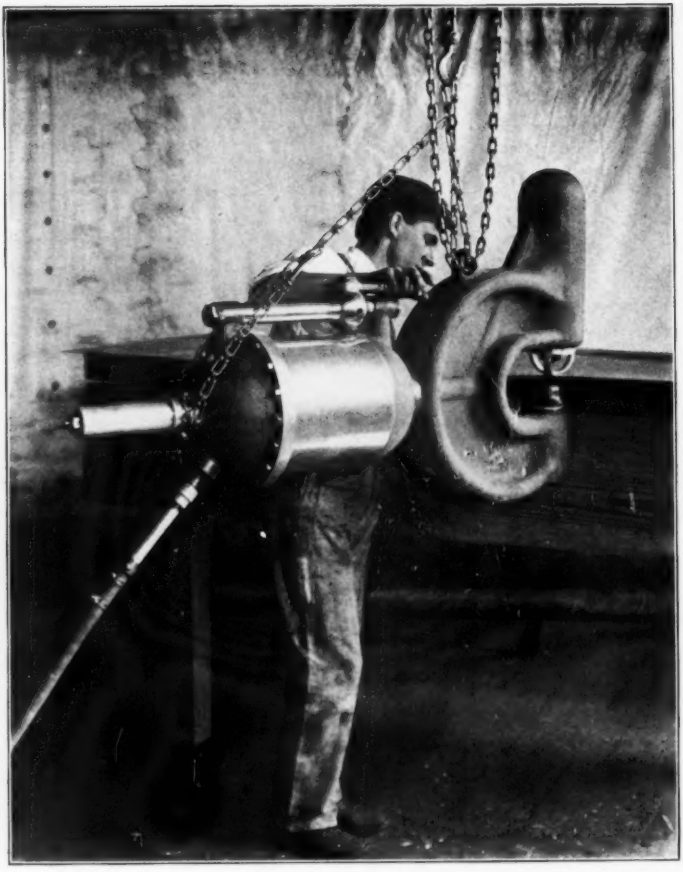
with hammer and chisel on a hurried job that should be in place, counting every stroke apparently, and making sure that he does not give too many for the pay he gets. Here is where the pneumatic tool comes to the rescue of the harassed boiler-maker, for one man goes around a seam, either caulking or chipping it, as a woman operates a sewing machine. There is no loafing with the pneumatic tool, for the man has perforce to keep up with it or willfully to spoil the job. It is literally a time-killer in the best sense of the word, for it walks over the work at a racing pace.

In old times the flanger was a great man—bigger than the layer-out—and it was a serious matter to lose him if he took a notion to change his base; but the flanger's task was a simple one to what it is in these days, for it was chiefly straight-away work, in no wise comparable to that done upon some kinds of modern boilers. The illustrations opposite, which represent steel plate flanged to the forms required for details of the Babcock & Wilcox boiler, illustrate the plasticity of modern steel boiler-plate, and the skill required for its manipulation. The header, on the right, is a square steel box, formed of one plate, the holes,

CONNECTIONS FOR BABCOCK & WILCOX BOILER.

These are examples of the results of the modern flanging method and materials.

of course being drilled. Imagine the consternation of the old-time flanger if required to produce these shapes! He would say it could not be done, and he would have been correct, too, for in his day, fifty years ago, there was no metal that would have stood the punishment required to shape it. Moreover, the sheets flanged years ago were not usually more than $^{5}/_{16}$ thick, rarely $\frac{3}{8}$; seldom, indeed, $\frac{1}{2}$ an inch thick; and to turn even these, if the shapes were at all out of the usual run, required an amount of discussion and pow-wow over the job that would discount an Indian council fire. Now, in these days, it would be a curious shape that would be given up as impracticable, whatever the thickness of the stock. The facility with which flanging or shaping of the details of steam boilers can be executed is rivaled only by drop-forging, which it very closely resembles in character. It has dispensed with castings to such an extent that there are none at all under strain in some modern boilers, and none anywhere except in the doors and fronts of stationary boilers. Even the dogs of hand-hole plates and man-holes are now made hollow in pressed steel, at a fraction of

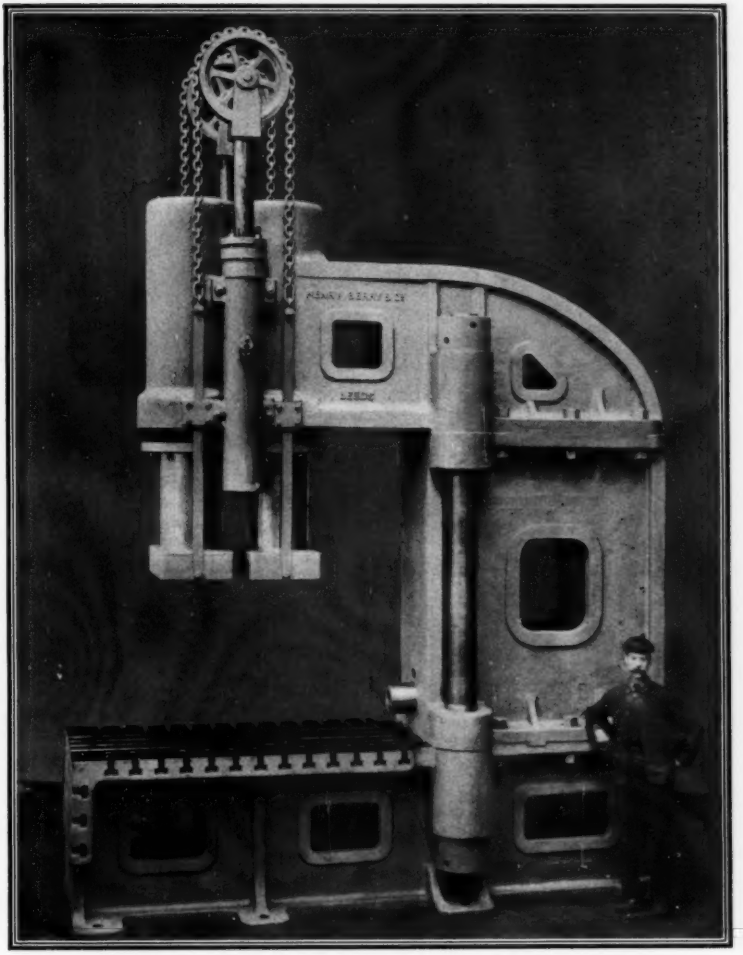


CASKEY PNEUMATIC PUNCH IN OPERATION.

The tool is also adapted to be used for riveting, with necessary changes in details of construction. F. F. Slocomb & Co., Wilmington, Del.

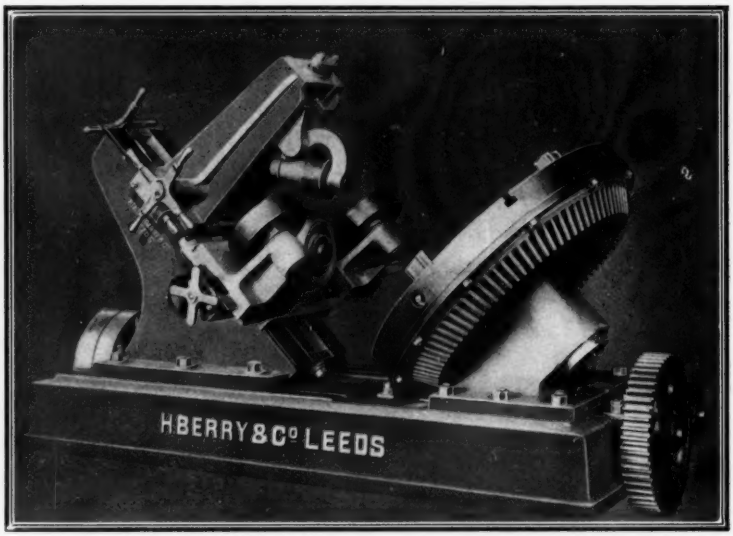
the cost of hand-forged dogs and of far greater strength than the cast-iron dogs in common use.

Hydraulic presses, in conjunction with dies or formers, (which are simply moulds of the shape required for any part of the boiler) are used for this work, although in some shops plain flanged heads of boilers and dished shapes are spun up, as it is called, in the same way that work is spun up in a lathe. Any thickness of metal is handled, up to



HYDRAULIC FLANGING PRESS. HENRY BERRY & CO., LTD., LEEDS.
A powerful machine made for the Leeds Forge Co.

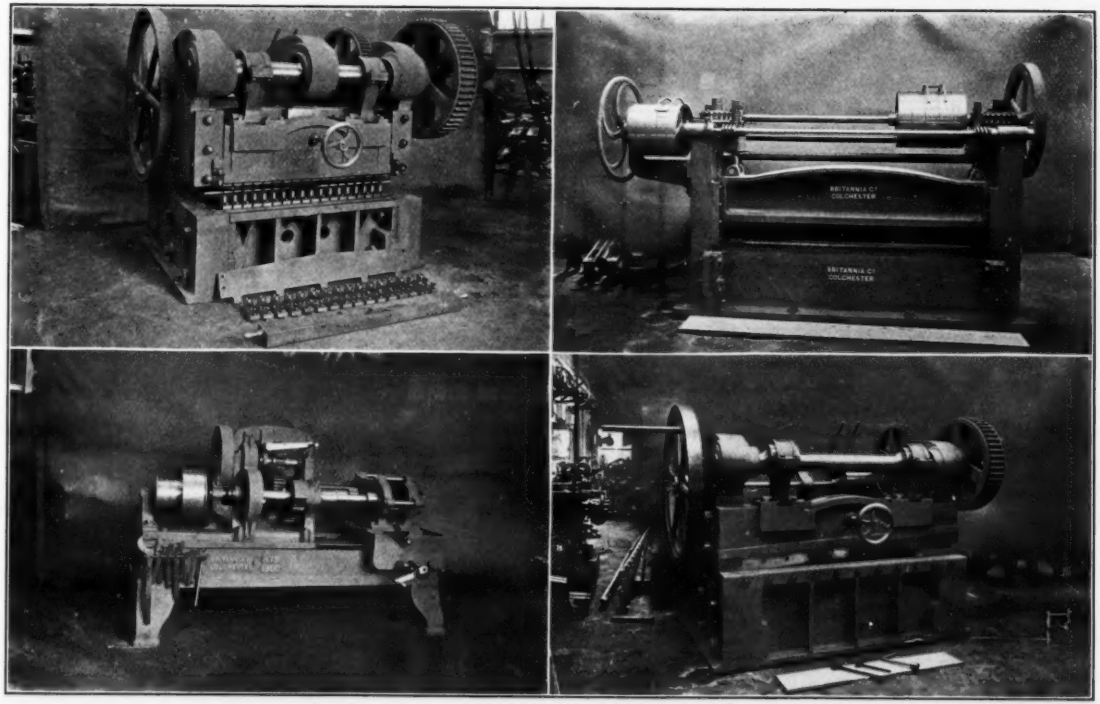
one inch and over, the heating being done in closed furnaces instead of open fires. The large steel mills now furnish flanged heads of all diameters, from $^{3}/_{16}$ of an inch thick and 12 inches diameter, up to 120 inches diameter by 1 inch thick, having flanges 5 inches deep; the beauty of the mill-flanged heads lies in their exactness to size, round-



ANGULAR FLUE FLANGING MACHINE. HENRY BERRY & CO., LTD., LEEDS.

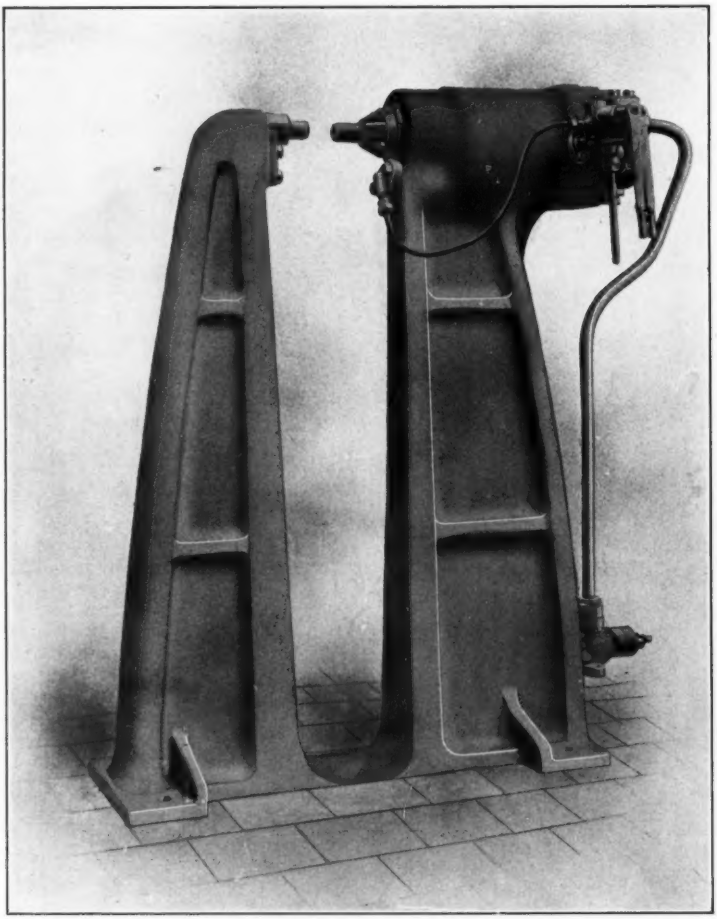
ness, and freedom from buckles, which last, in hand work, are a contingency by no means remote. The cost of the machine-flanged heads is but a fraction of that incurred by hand-work. In addition to the flanging, flue holes from 6 inches to 56 inches diameter can be placed where needed and flanged with great accuracy, so that practically the worst work the old-timer had to do is now done for him and the finished parts shipped ready for assembling. As an instance of the saving in expense to boiler makers by modern methods over hand work, steel plate saddles for man-holes, ready to rivet on the shell, with rivet holes *in situ*,—in fact the man-hole plate complete with the exception of the gasket only—can be had for $10, plus the cost of the plate which amounts to very little more; made by hand this detail would cost double that or more according to locality.

In laying out seams on plates, the old-time boiler maker had a lot of templets in the shape of strips of wood from ¼ of an inch thick upward, according to length, and about 3 inches wide. In these the pitch of the rivet-holes (distance from centre to centre) was laid off, after which holes were bored of the size of the rivets; in transferring this pattern to the plate the templet was laid on it and the holes located by a brass tube the size of the hole, armed with white lead, which left a circle on the plate. The boiler maker then centered the marks



A GROUP OF MODERN BOILER-MAKING TOOLS.

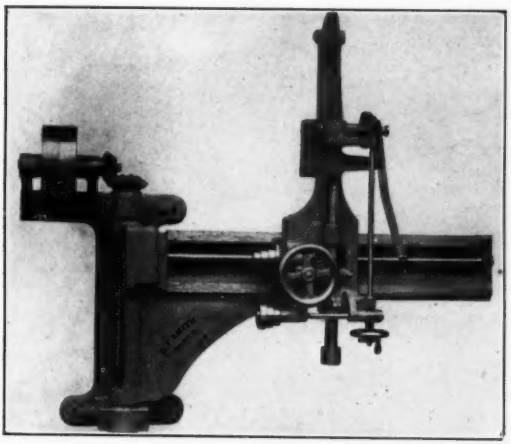
Above on the left is a multiple punching machine; on the right a plate flanging machine. Below on the left is a double spindle boring and tapping machine, and on the right a powerful plate shearing machine; all by the Britannia Company, Colchester.



HEAVY FIXED RIVETTER. HENRY BERRY & CO., LTD.

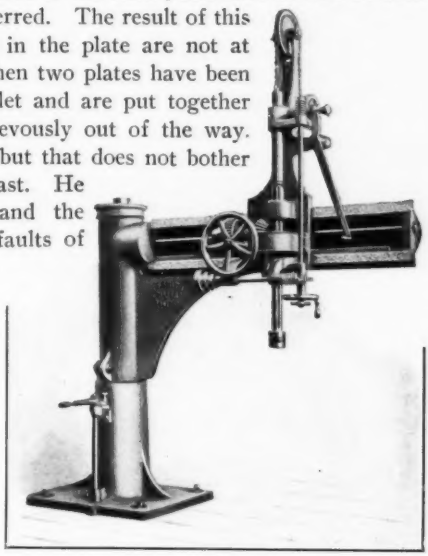
as accurately as he could with a tool, and the sheet was ready for the puncher, for no holes were drilled in old times—it cost too much.

Now it is a curious fact in boiler-making shops that the punching press is usually set in the darkest corner of the place; some modern boiler shops are as short-sighted in this particular as the old-timer was; but if there is anything that the puncher needs for accurate work, it is natural light—not artificial light— and plenty of it, for trouble

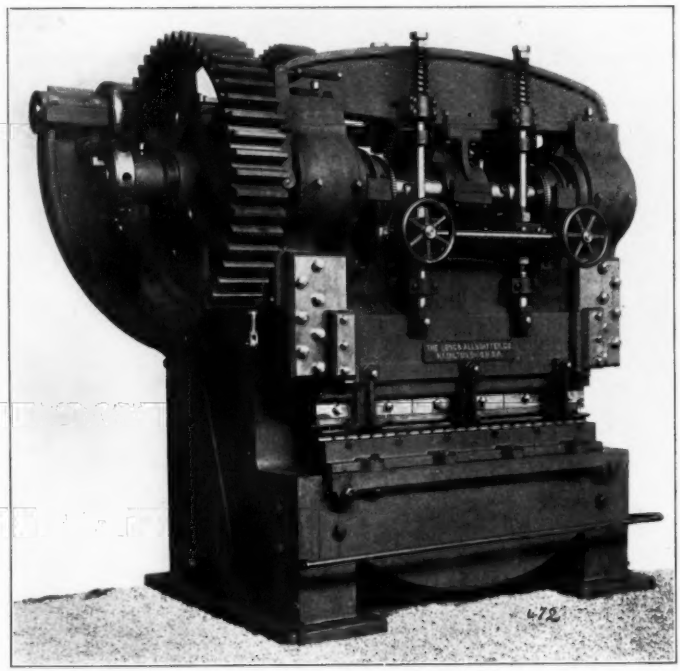


WALL RADIAL DRILLING MACHINE.
G. F. Smith, Halifax.

begins as soon as the press is started. It would seem to be the simplest thing in the world to cause a slow-moving punch to strike accurately in the centre of a big punch mark, but even with great care and a conscientious intention to do it on the part of the attendant, punches have a sort of moral delinquency, so to speak, and a determination that the hole shall be a trifle to one side or the other; and once started on their journey they cannot be deterred. The result of this is that the punched holes in the plate are not at all like the templet, and when two plates have been laid off by the same templet and are put together to be riveted they are grievously out of the way. The rivets will not go in, but that does not bother the average man in the least. He knows that his reamer and the drift-pin will correct the faults of the punch, but the less said about the holes themselves after these rude appliances have had their will of them, the better; oblong holes of varying diameters and sheets cracked as to the edges are frequent; but "out of sight out of mind" is a maxim that covers a multitude of sins in a boiler-



UNDER-DRIVE PILLAR RADIAL DRILL.
G. F. Smith, Halifax.

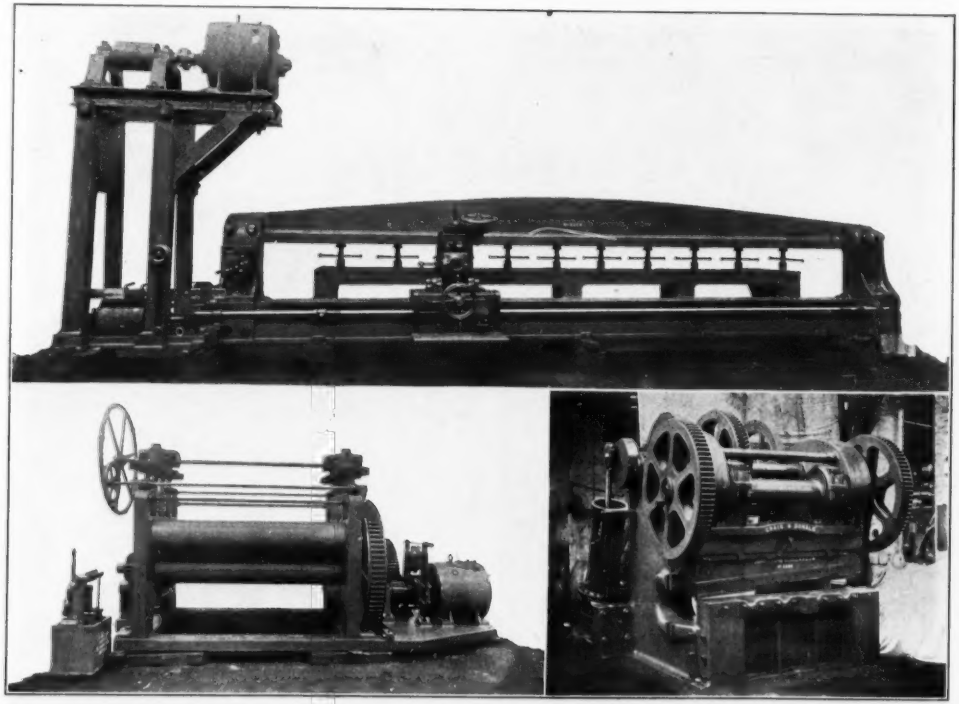


HEAVY DOUBLE-GEARED MULTIPLE PUNCH.

Long & Alstatter Company, Hamilton, Ohio.

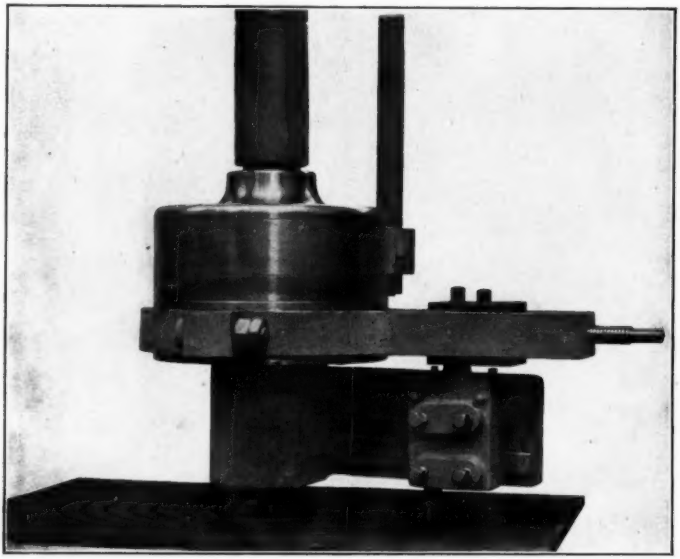
shop. The use of the drift-pin is prohibited in the best shops, and in fact, there is no longer any reason or occasion for it. The rivet holes in seams are now automatically punched and spaced by a special machine, which never errs either in pitch or locality of the hole, and the unfortunate helper, who formerly pretended to steady the long end of a sheet while the man at the punch guided it at the crucial moment, has lost his occupation, and with the loss has escaped the burning words and reproachful looks the man at the punch hurled at him when a hole was made in the wrong place; the fault was always charged to his account.

Besides the flanging and riveting machines in use in modern shops, there are a great many other special machines which reduce time and labor costs in a marked degree; hand-hole cutters for one, and punches that will stab an inch-and-a-half hole through wrought steel one inch



HEAVY BOILER-MAKING TOOLS.

The upper machine is a heavy plate planer operated by an electric motor; below on the right is a powerful plate shears, and on the left a set of flattening rolls; all by Craig & Donald, Johnstone.

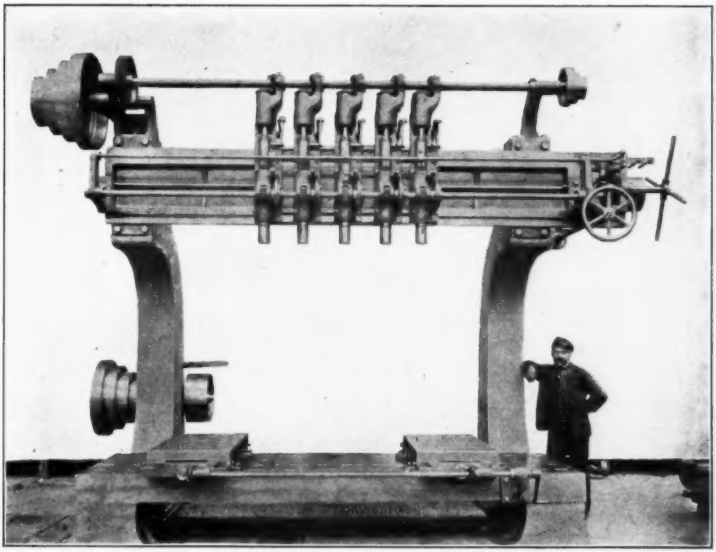


OVAL HOLE CUTTING MACHINE.

Adjustable by eccentric for various ovals and operated in connection with a drilling machine. John Hetherington & Sons, Ltd., Manchester.

thick; shears that will bite through bars four inches wide by one inch thick, and portable power riveters that both rivet and hold on in the most inaccessible parts of the boiler. In fact, a modern boiler shop is a first-class machine-shop, and the work done is really machining of the highest character. Especially is this true of sectional water-tube boilers, where the joints which have to be broken to clean tubes are all iron and iron, without the intervention of any adventitious aid or material to make them tight. The familiar tube-sheet cutters, or drillers of tube holes, are not new in application, but they have been much improved and are substantially changed from what they were fifty years ago, while air lifts, hydraulic lifts, chain blocks, and enormously powerful rolls in the modern boiler shop have wholly changed its aspect and operation.

All these things have also changed the character and quality of the assembling and construction of steam boilers of the best class, by which is meant those of first-quality plate and from strict specifications. These last are much more exacting than they were half a century ago; as a fact, there were none whatever extant then, every boiler being

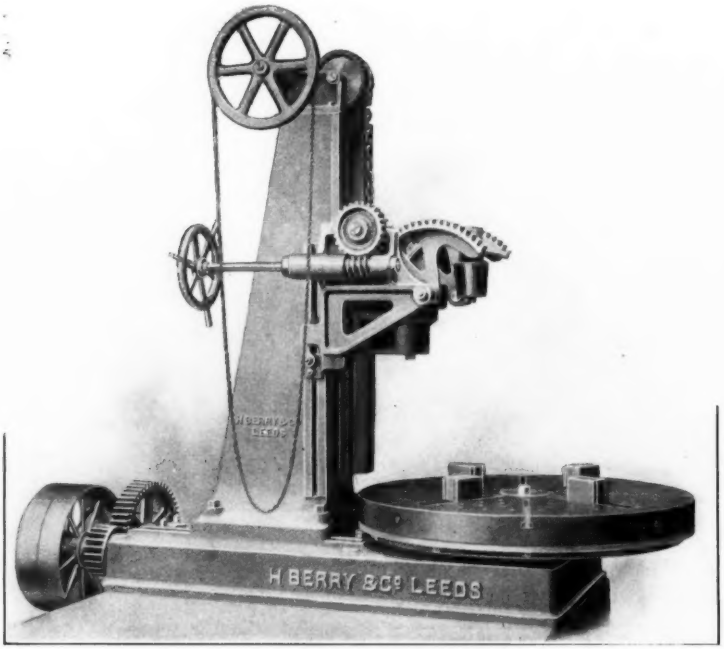


FIVE-SPINDLE DRILLING MACHINE.

A special tool, used in the construction of water-tube boilers. Noble & Lund, Felling-on-Tyne.

considered to fulfill its function and have a reason for its existence if it made steam in sufficient quantities for the engine attached to it. Factors of safety were ignored; this is the literal truth, in most all cases. The only test was a water and a steam test for tightness, the tensile strength of the plate itself being assumed, or, in other words, guessed at. I know of steam boilers 15 feet in diameter of shell by 18 feet long thickness of plate $^{5}/_{16}$ of an inch, which were run under forced draught for years at 50 pounds per square inch gauge pressure; this is the limit for steel plate of 60,000 pounds per square inch tensile strength with a safety factor of four only. These were iron boilers, of unknown tensile strength, but they never gave out, I am glad to say, for the reason that I was in charge of them; or, if this sounds slightly ambiguous, I will add that I am glad they did not give out. Many instances in the early steam history of the United States could be adduced, particularly in river boats, where the pressures far exceeded that just mentioned; some of them survived the stress and others did not.

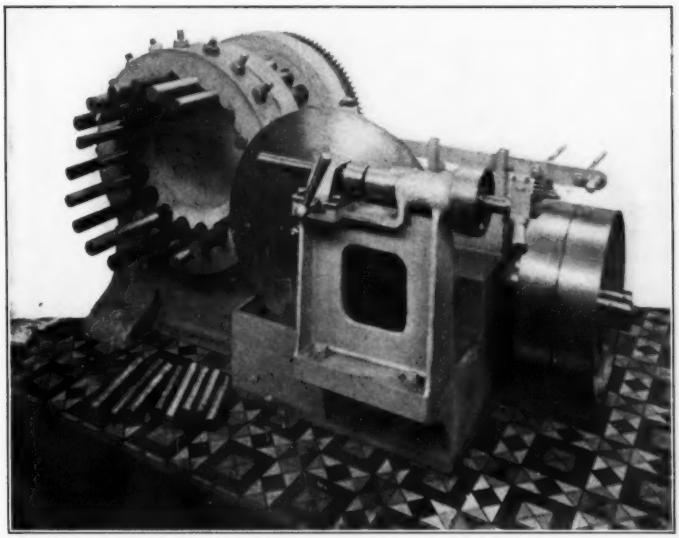
The very stringent rules of the Treasury Department for the steamboat inspection service of the United States as relates to the construc-



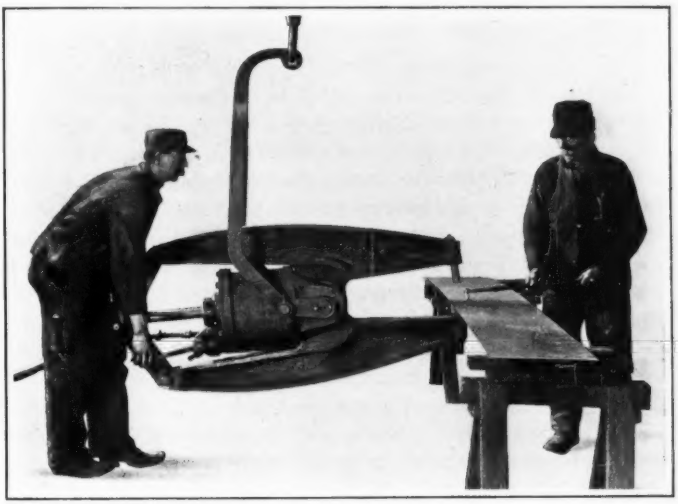
IMPROVED FLUE FLANGING MACHINE. HENRY BERRY & CO., LTD., LEEDS.

tion of marine boilers are strictly enforced by capable officers, and there is no influence of any sort whatever that can be brought to abate any of them. The thickness of metal for given pressures, as well as the quality of it in all that relates to tensile strength and elasticity, are set forth in the manual published by the government for constructors, and no departures or evasions are countenanced. All boilers used in steam vessels of whatever class must be approved as to their types and designs before they will be allowed to be used, a Board of Supervising Inspectors meeting in Washington each year for this and other business of their departments. No one can build a new type of boiler and call for inspection on it without this approval. The result to the traveling public is almost absolute immunity from disasters by failure of boilers, the actual explosions being very rare.

The construction of marine boilers of the shell type, Scotch boilers as they are termed, is carefully watched through every stage, and there are a good many processes to be gone through before such boilers are



STAY CUTTING MACHINE. NOBLE & LUND, FELLING ON TYNE.



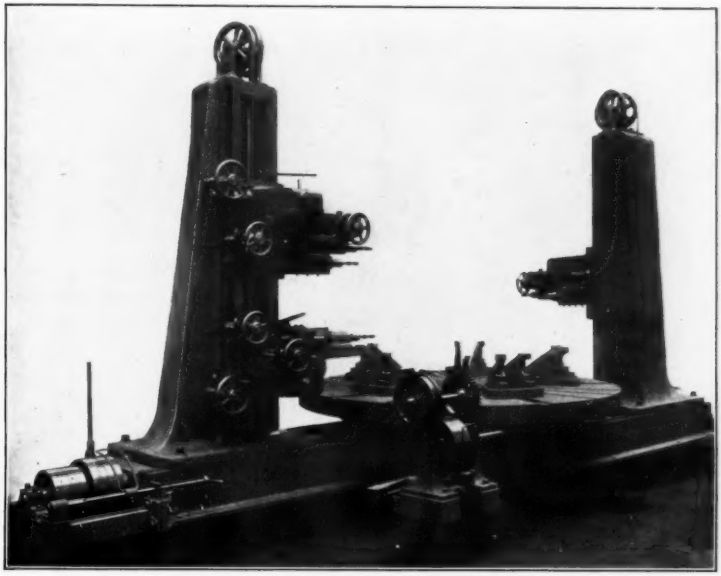
PNEUMATIC RIVETER "ALLIGATOR PATTERN."

Capacity 300 rivets per hour with two men and two boy helpers. Bethlehem Foundry and Machine Co.

ROLLING IN 4½-INCH BOILER TUBES WITH PNEUMATIC TOOL.

Philadelphia Pneumatic Tool Company.

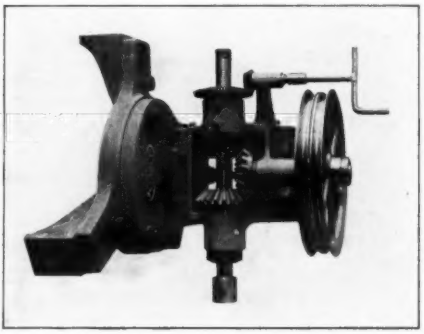
ready for steam. The shells of Scotch boilers are enormously thick, according to the pressure at which they are to be worked, the diameter and thickness of the shell regulating it. For 150 pounds gauge pressure, a Scotch boiler of 15 feet diameter would be made of $1^{17}/_{64}$ inch steel plate, weighing some 54 pounds per square foot. The rivets would be 1¼ inches in diameter, also of steel, and the horizontal seams would be secured by butt-straps of thickness equal to that of the plate. In boilers for government work the sheets are pickled in a bath of muriatic acid diluted with water, in order to remove the mill-scale, leaving the surface clean so that defects of any kind can be seen, and after being bent to the required diameter in rolls, have the heads fitted to them, all rivet-holes being subsequently drilled upon a special machine, so that there is no possibility of any of them being out of the way. When completed the parts are all taken down and the burs left by the drilling removed, as well as any scale or dirt which may have accumulated during the process; the surfaces where laps occur are thoroughly washed with lye to clean off any grease, so that positive



IMPROVED BOILER SHELL MULTIPLE DRILLING MACHINE.
John Hetherington & Sons, Manchester.

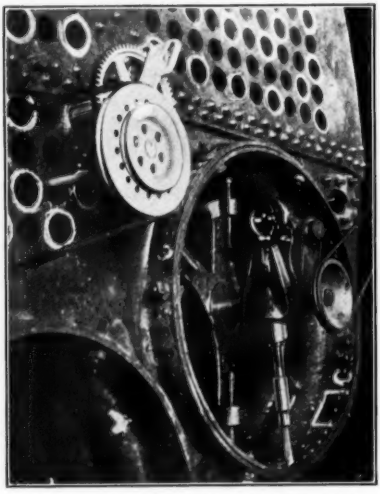
conjunction of the surfaces will be had when riveted finally. This practice as regards removing the grease is followed all through the manufacture, particularly in the tube-sheet holes and tubes themselves, an undiscoverable film of it militating against their being steam-and-water-tight under the great testing pressures to which they are subjected when completed. In the merchant service by Lloyd's and the Bureau Veritas rules this test pressure is double the working pressure, and it is needless to say that it is searching. Nothing but actual iron and iron contact all through and the very best workmanship will pass muster. I mentioned previously that the plates in a Scotch boiler of a certain diameter were $1\,^{5}/_{16}$ inches thick, but there are much thicker than this in use, those in one of the American line vessels having plate $1^{9}/_{16}$ inches thick. The work of rolling these shells to dimension is one of the most difficult tasks in their manufacture, and the final caulking is done with sledges on the usual round-nose tool, instead of by hand-hammers. The rivets are 1½ inches diameter and a pressure of 135 tons is exerted on them when closed in place.

In connection with this subject of modern boiler making, I must

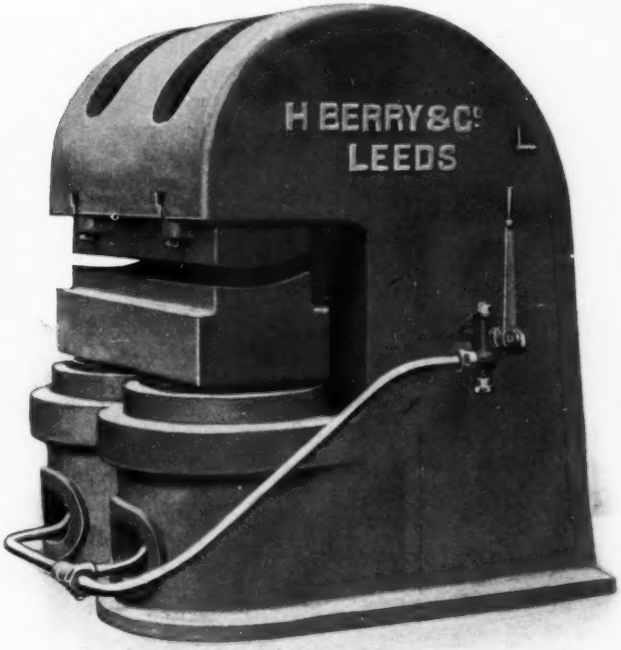


PORTABLE DRILLING MACHINE.
John Hetherington & Sons, Manchester.

advert to the exceedingly unsatisfactory condition of rating their power—an anomalous term, for a boiler cannot exert any power under any circumstances. It merely furnishes a means of power to other machines, yet boilers are sold wholly upon their horse power. A quarter of a century ago, at the Centennial Exposition, a standard was adopted which has been accepted in many contracts and specifications, but the engineering practice since that time has advanced, so that it requires very much less steam per horse-power hour than it did at the time of the Centennial. It is a pretty poor engine in these days of compound and triple-stage expansion that requires 30 pounds of water per hour per horse power, so that by the standard mentioned boiler-makers and purchasers are both handicapped; the boiler maker in furnishing a larger boiler than the engine needs, and the buyer in paying for it. It is not to be supposed that the boiler maker alone is to suffer for the want of a proper standard of rating. Just how he may incur obligations and liabilities which he should not is shown in a case of recent occurence. A commercial firm ordered a boiler of a certain nominal capacity, say 25 horse power, which was furnished and paid for promptly on presentation of the bill. This boiler was sent to the other side of the world, and after



BOILER FLUE DRILLING MACHINE AND PEDDIE'S TAPPING APPARATUS.
Showing these portable tools at work on a marine boiler. Smith & Coventry, Manchester.



HYDRAULIC PLATE PRESS. HENRY BERRY & CO., LTD., LEEDS.

nearly a year had elapsed, the boiler maker was notified by the agents of the commercial firm that payment had been refused them, for the reason that the boiler had been tried, (by "the best engineer" to be had) and would not develop more than 8 horse power. The agents therefore requested the boiler maker to refund the money paid, upon the ground that the boiler was not as represented. This the boiler maker declined to do, and demanded proof that the boiler would not do what it was sold for by citation of all the circumstances of the trial, which last had not been furnished. Now this boiler was not new in any respect, except in certain arrangements of the several surfaces, grate and heating, the proportions of which were those in general use; numbers of the boilers had been sold in various parts, so that there was no issue in the boiler-maker's mind

as to his liability, and none concerning the action of the boiler, except mismanagement of some kind; the whole difference between the two parties to the contract turned upon what a boiler horse power really is.

In so far as the evaporation of 30 pounds of water per hour at 70 pounds gauge pressure, with feed at 100 degrees is concerned, it is not at all difficult to do it, even with a boiler that is not by any means what it should be in other respects. After the trial it may not come within 25 per cent. of its normal rating. New boilers, when everything is clean and the grates are in good condition, are very much better evaporators than they are after they are dirty all through, from mud-drum to dome.

This question of rating boilers has been raised time and again in discussions at meetings and in the technical papers, but it is still unsettled. It should not be difficult to arrive at some solution of the matter, but I have no suggestions to offer myself upon it. A commercial solution of the question is very difficult, for buyers do not know of any other term than horse power, and it would take about one hundred years to get one into general use. The question of boiler power could be very easily settled for boiler makers, or to their satisfaction, by fixing so many feet of heating surface and grate-surface, with a given height of stack, burning a certain number of pounds of coal per square foot of grate per hour, said proportions to constitute one horse power. This would leave the buyer to get the best evaporation that he could, let the same be more or less. I am afraid, however, that there would be as much argument after the adoption of this rating as before; the only benefit to the trade would be that boiler makers would not be in the controversy, so I leave the subject where I found it.

THE GROWTH OF ECONOMY IN MARINE ENGINEERING.

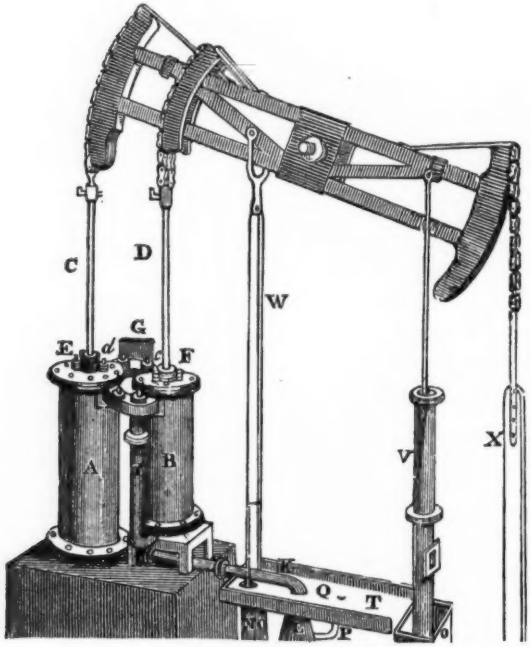
By Walter M. McFarland.

II.—THE INTRODUCTION OF HIGHER PRESSURES AND COMPOUND ENGINES.

In this, the second of Mr. McFarland's valuable articles, the subject is developed from the period of the simple engine to the advance in economy which followed the introduction of compounding; the work of such pioneers as Elder, Loring, Emery, Isherwood, and others being discussed. The following papers will deal with the introduction of triple expansion, and the succeeding improvements which have made the modern marine engine capable of developing a horse-power with one-tenth of the fuel demanded by the early engines and rendered present speeds and capacities possible.—THE EDITORS.

IT is almost impossible to draw a sharp line separating one period in the growth of the steam engine from another; but for convenience this can be done roughly, and we might say that the simple-engine period extended to about 1865 and the compound-engine period from about 1865 to about 1885. The invention of the compound engine dates back almost to the time of Watt's patent, for a patent was granted to Jonathan Hornblower in 1781 for a compound or double-cylinder engine, and in 1804 Wolff also used a two-cylinder engine expanding the steam from six to nine times. As has often been pointed out, the compound-engine did not operate under satisfactory conditions with the low steam pressures then prevalent, and its actual introduction upon a commercially successful scale did not occur until eighty years after the time of Hornblower.

During the decade from 1860 to 1870 British engineers had been taking advantage of the higher steam pressures, which had become common, to re-introduce the compound engine, the foremost among them being John Elder of the firm of Randolph & Elder; still later this concern became the Fairfield Engine Works, which have built so many magnificent specimens of machinery. By the early 70's the use of the compound engine had become almost universal; steam pressures had risen to sixty pounds and rotational speeds had materially increased. In 1871 Mr. J. W. King, the engineer-in-chief of the American navy who succeeded Mr. Isherwood, made a visit to Europe and on his return urged most strongly the adoption of the compound engine for all naval vessels. In a later report printed in 1877, after he had spent



(*Hornblower's Engine.* 1781.)

HORNBLOWER'S COMPOUND PUMPING ENGINE.

From Galloway's treatise on the steam engine, 1830. The construction of these engines was stopped by Watt, as they infringed his patent on the separate condenser.

more than a year in Europe, he again discusses the use of the compound engine and concludes by saying:

> "In the face of these facts, further discussion on the subject of adopting the compound engine for the vessels of our own navy is as useless as would be the discussion of the relative merits of the screw propeller and paddle wheel for ships of war."

The compound engines which were in use had demonstrated very thoroughly that they possessed a marked economy over the simple engines immediately preceding them, but in spite of this there was considerable opposition to the general introduction of the compound engine. This came from two sources. One was in naval circles and was represented by certain reactionary but influential executive officers who feared that the danger of boiler explosion would be greatly increased by the use of the higher pressures which were necessary with

the compound engine. They forgot that with reliable material and proper design the high-pressure boiler was just as safe and worked with the same margin as the boiler of lower pressure. They also forgot that as far as damage due to the scalding effect of the steam is concerned, low-pressure steam was just as bad as high. As a matter of fact, it may be remarked incidentally that there is not a case on record of a well designed and carefully built high-pressure boiler ever having exploded. It has been surmised that some steamers which were lost at sea without anything being known as to the cause were blown up, but there is no ground for this belief, particularly as thousands of boilers have worn out without ever giving trouble on this score.

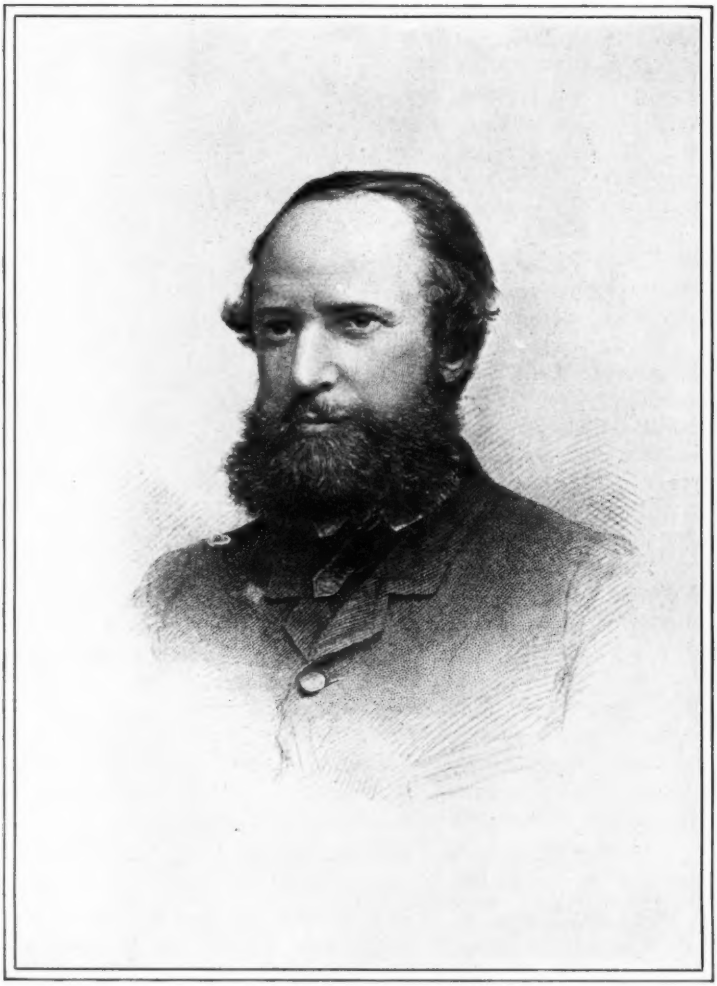
JONATHAN HORNBLOWER.
Inventor of the Compound Engine.

The other class of objectors, curiously enough, included engineers who made some pretension to scientific attainments, and some of them indeed were men of the very highest standing. They claimed that there was no virtue in the compound engine as such, and that there was no reason why a simple engine working with the same initial pressure and the same ratio of expansion should not give exactly the same economy as the compound engine. The great name of Professor Rankine was quoted as sustaining this view on account of a statement in his well known text book on the steam engine, which is as follows:

> "It is to be observed, then, as a general principle, that the energy exerted by a given portion of a fluid during a given series of changes of pressure and volume depends on that series of changes, and not on the number and arrangement of the cylinders in which those changes are undergone."

In 1870, however, two years before his death, Professor Rankine wrote a memoir of his friend John Elder, in which he expressed himself very clearly as to the importance of compounding as a means of preventing liquefaction, thus revising his former opinion.

Probably the most notable case of attempting to carry out the idea that the simple engine would give the same results as the compound

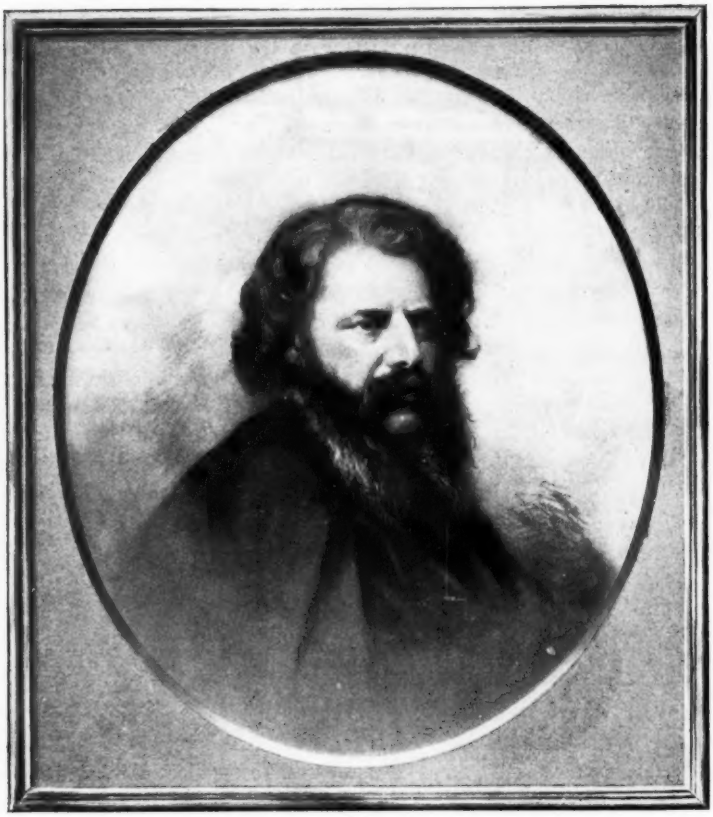


JOHN ELDER, 1824-1869.

To Mr. Elder is due the successful introduction of the marine compound engine, as well as many other details affecting steam economy in marine engineering, including steam jacketing, surface condensers, etc. He also advocated triple expansion, but died before its realisation. By courtesy of Mrs. John Elder.

was in the Allan line of steamers. The superintending engineer, believing firmly that the demand for compound engines was a fad, determined to make a crucial experiment. In two new vessels of that line, which were of about the same size, he had the machinery the same except that one was fitted with compound engines and the other with simple engines. Both used the same steam pressure (60 pounds) and the same ratio of expansion. Every care had been taken to make the machinery, as far as design and workmanship were concerned, the very best in both cases. The two ships were put on the line between Liverpool and Quebec, Canada, and the results as to economy of fuel were not greatly different. Unfortunately, however, there were unexpected difficulties in the operation of the simple engine consequent upon the serious shocks resulting from the rapidly varying pressures on the crank pins. So serious were these that not only the crank shaft but also the stationary parts of the engines began at an early day to show signs of weakness, and in a short time gave out altogether. As already stated, the superintending engineer was the designer of the machinery, and it was only after his personal efforts failed to keep the ship with simple engines running that he reluctantly decided to remove them and to substitute compound engines in their stead.

It will be noted that in the above case of the steamers of the Allan line the economy of the two methods of working is *said* to have been about the same. It seems very probable that, as the superintending engineer had staked his reputation on this result, this may have had some effect upon the figures which were reported. Other experiments made by engineers of reputation without any bias showed, as might have been expected from the Michigan experiments, that this is not the case, and we now know very thoroughly that after a certain very limited degree of expansion in a cylinder has been passed the losses consequent upon liquefaction due to the alternate heating and cooling of the cylinder walls overbalance any hypothetical gain due to expansion. In August, 1874, Messrs. Loring and Emery conducted a very interesting series of trials on the machinery of three revenue cutters whose hulls and boilers were alike but whose engines were different. One had a compound engine of the receiver type; the second a single-cylinder, but carried high-pressure steam with a considerable degree of expansion; while the third had a single-cylinder and carried steam of a lower pressure. The steam pressure for the compound and high-pressure was 67 pounds and for the low-pressure 32 pounds; the ratios of expansion were, for the compound engine, 6; for the high pressure, 3.5, and for the low pressure about 3. The results in steam per horse-



WILLIAM JOHN MACQUORN RANKINE, 1820-1872.

Regius Professor of Civil Engineering in the University of Glasgow; author of many important engineering works; one of the originators of the mechanical theory of heat, upon which all steam engine improvement is based. From the original portrait in the possession of the American Society of Mechanical Engineers.

power hour were, for the compound engine, 18.38; for the high-pressure, 23.9, and for the low-pressure, 26.9.

A very great advantage possessed by the compound engine, besides the increased economy, was the reduction of the stresses on the engine and the higher ratio of mean to maximum stress. The low-pressure cylinder is as large as would be required for a simple engine doing the same work with the same total ratio of expansion, but the maximum

pressure which comes upon this large piston is only a fraction of the boiler pressure. This higher pressure comes upon the small piston, and the result is that, as each cylinder does about half the total work and as the maximum stresses are so much reduced, the sizes of piston rods, connecting rods, and similar parts are very much smaller than would have been necessary in simple engines which at the beginning of the stroke received the full boiler pressure.

An incident which occurred in connection with the introduction of compound engines in the American navy, and which was repeated when triple-expansion engines were introduced, makes it worth while to call attention to a curious circumstance in connection with reports of economy of marine engines. When it had been decided to adopt the compound engine a board of officers considered the question of a suitable size for certain vessels, and the bunker capacity which should be provided. The experience with compound engines at that time was almost wholly in the merchant service, and it was commonly reported that under ordinary conditions a horse power was obtained for about two pounds of coal. This was accepted as a fact and the bunker capacity based upon this idea. Experience with compound engines has shown that this estimate was very wide of the mark, and it would probably have been much safer to have used three pounds per horsepower as the basis. It is very doubtful if any marine compound engine in regular service ever got a horse power for less than two and one-half pounds of coal. The probability is that the coal expenditure was not carefully taken and was too low, and that the horse power used for the divisor was based on trial-trip records and was thus very much too high.

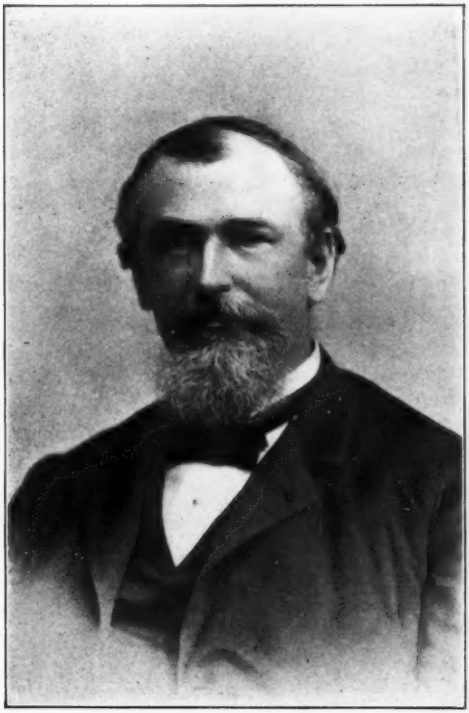
With the low steam pressure used in connection with simple engines, the boiler in general use was what was commonly called the "box boiler," because it had flat sides and was of a roughly cubical shape. Such boilers depended for their strength upon the bracing, and, even with low pressures, the braces formed such a network that it was difficult to gain access to the interior for cleaning and repairs. As steam pressures rose with the use of the compound engine, such a boiler would have been entirely inadmissible, and, as a result, the cylindrical boiler was introduced, whose cylindrical portion required no bracing. The correct road to economy had now been discovered, and consequently, as metallurgical processes developed and open-hearth steel of reliable quality was manufactured, it became possible to increase pressures and there was a steady progress along this line. At the same time there was improvement in workmanship, so that higher

COMMODORE CHARLES H. LORING, U. S. N.

Engineer-in-Chief, U. S. N., 1884-1887. Past-President American Society of Mechanical Engineers; associated with Mr. Charles E. Emery in important experimental researches in steam engineering.

rotational speeds were possible. Both of those were of benefit in reducing the cost of power.

As has already been mentioned, steam jacketing had been used to some extent, and with the general use of the compound engine the use of steam jackets became universal. The benefits derived were not always obtained, because care was not always taken to keep the jackets well drained by the use of efficient automatic traps. The economy to be derived from jacketing has not gone entirely unquestioned, and very interesting experiments have been made from time to time to test various questions in this connection—notably the proper steam pressure to use in the jackets of the different cylinders. It has sometimes been deemed advisable not to jacket the high-pressure cylinder, for the



CHARLES E. EMERY.

Mr. Emery's researches in steam engineering in association with Commodore C. H. Loring contributed most valuable data in connection with compounding and steam jacketing.

reason that a certain amount of moisture in the steam there has been considered beneficial; but the fact seems pretty well established that the jacket steam pressure should never be lower than the highest steam pressure in the cylinder to which the jacket is applied.

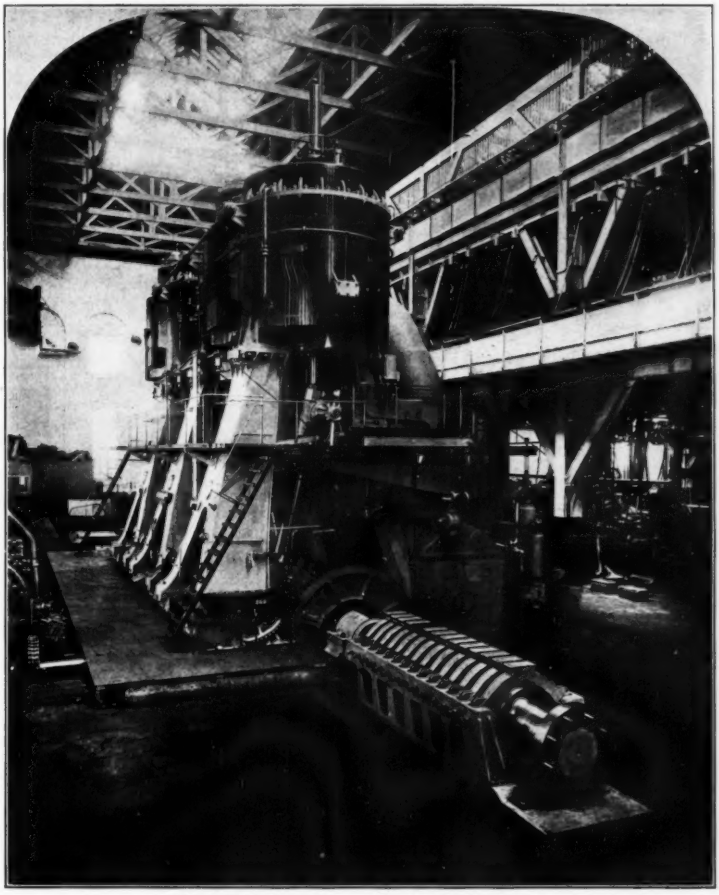
Two general types of the compound engine were used at first—the "tandem," in which the small cylinder was co-axial with the large one and usually placed above it (a vertical arrangement); several of the White Star steamers were built with pairs of these tandem engines; the other type was known as the "receiver compound engine," because there was an intermediate space between the two cylinders, which permitted placing their cranks at right angles when two cylinders or at 120 degrees when three were used, so as to make the engines

much handier in manipulation. This latter type became the one universally used, and, except in war vessels, the cylinders were always vertical.

As has been stated, the low-pressure cylinder of a compound engine has to be of the same size as the simple engine with the same ratio of expansion, and it was soon found, as the sizes of engines increased, that the low-pressure cylinder when but one was used would be inordinately large. Some were, indeed, built with as great a diameter as ten feet. It became the rule, therefore, to divide the low-pressure stage of the expansion between two cylinders, which were usually placed one on each side of the high-pressure. This enabled the cranks to be set at angles of 120 degrees, which gave a very uniform crank effort.

In the early days of the compound engine, when the lesson that expansion could not economically be carried beyond very reasonable limits had not been thoroughly learned, it was the custom to fit what were called "cut-off valves" to both the high- and low-pressure cylinders. These were adjustable through a considerable range, the idea being to vary the power developed by the range of the cut-offs, while the steam pressure was kept at the maximum. Obviously this applied much more to the engines of naval vessels, which cruise at very varying speeds, than to the engines of merchant steamers which usually run at a constant speed. These special cut-off valves were rather complicated and required special eccentrics, and it is doubtful whether they were ever of great value. They were at first used in both naval and merchant vessels, because, apart from the desire to vary the ratio of expansion, it was impossible with a single slide valve to provide for a high ratio of expansion without badly deranging the exhaust and compression. The independent cut-off enabled the desired ratio of expansion to be obtained, while the exhaust and compression were attended to by the main valve. Experience finally showed that there was no real gain in economy in cutting off earlier in the high-pressure cylinder than about five-eighths, which could be done by the main valve, and when, as in naval vessels, it was desired to get a greater ratio of expansion for lower powers, it could be done by means of the link. A very simple means was found of arranging the suspension rod of the link so that whatever the degree of expansion in the ahead motion, when the link was thrown over for backing it would be in full gear.

In the latter part of 1880, Chief Engineer Isherwood conducted a most interesting and valuable series of experiments with the com-

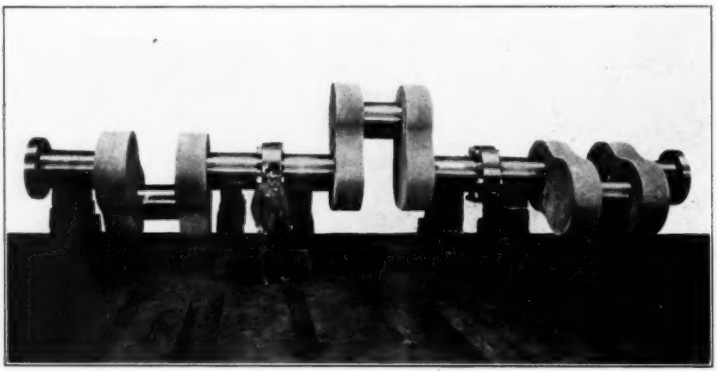


ENGINES OF THE SS. UMBRIA AND ETRURIA.

The last great compound engines for Atlantic liners. Built by John Elder & Co., Glasgow, for the Cunard Steamship Co. Cylinders: high-pressure 71 inches, low-pressure, two of 105 inches diameter; stroke 6 feet; 14,500 indicated horse power. By courtesy of the Fairfield Shipbuilding and Engineering Co.

pound engine of a Herreshoff yacht called the Leila, for the purpose of determining certain points in connection with the economy of compound engines when operated under different conditions, one of which was the distribution of power among the cylinders by varying the low-pressure cut-off without changing that of the high-pressure. Ordi-

narily, unless the cut-off in the low-pressure cylinder was somewhat earlier than that due to the link in full gear, the high-pressure cylinder would develop rather more than its share of the work. These experiments showed that not only could the distribution of power be varied among the cylinders, but that by the judicious use of the low-pressure cut-off the total horse power of the engine might be increased for the same steam consumption, or, in other words, that a slight gain in economy might result. It may be remarked incidentally that these experiments on the Leila showed one of the reasons why naval vessels in ordinary cruising can never be expected to give the same economy as merchant steamers, which work constantly under full power. The naval



CRANK SHAFT OF SS. UMBRIA AND ETRURIA.

Built up of Vickers' steel by the firm of John Elder & Co., and used on these, the last of the great compound engines, prior to the general introduction of the triple-expansion system. The shafts are 26 inches in diameter, and weigh 84 tons. By courtesy of the Fairfield Shipbuilding and Engineering Co.

engine must be designed for the maximum power which is required. The usual cruising speed is not much greater than half the speed corresponding to full power, with the result that the power of the engines for low speeds is about one-tenth that of full power. It is, therefore, utterly impracticable to attempt to get this low power by maintaining full boiler pressure and using a great ratio of expansion. The actual operation is to carry about two-thirds full pressure in the boilers and by throttling get an initial pressure in the cylinder which will allow a reasonable degree of expansion to be maintained. The Leila experiments showed, for example, that with a nearly constant degree of expansion, due to a cut-off a little earlier than half stroke in the high-pressure cylinder, the steam per horse-power hour, which, with a boiler

pressure of 129 pounds, was 16.3 pounds, rose to 20.9 pounds when the steam pressure had been reduced to 55 pounds, and to 32.7 pounds when the steam pressure had been reduced to 21 pounds. It will be observed that these experiments are the inverse of the Michigan experiments, where the steam pressure was kept constant and the ratio of expansion varied. In the Leila experiments the ratio of expansion was kept practically constant and the steam pressure varied. The results, however, were the same. When the ratio of expansion became much greater than about one-twelfth of the boiler pressure there was a decided diminution in economy.

The Research Committee of the British Institution of Civil Engineers conducted an exceedingly valuable series of experiments on marine engines of different types to determine carefully their economy, and in 1888 and 1889 tested two compound-engine vessels. In one of them the boiler pressure was 80.5 pounds and the revolutions per minute 86.5. The coal per square foot of grate per hour was 26.1, and the coal per indicated horse power per hour 2.9. It is to be noted that a part of this high cost of power was due to the use of forced draft in the boiler, which reduced its economy. In 1888 they tested another compound engine, where the steam pressure was 56.8 pounds and the revolutions per minute 55.6. The coal per square foot of grate 19 pounds and the coal per indicated horse-power hour 2.66. The results of these cases are deserving of absolute respect, for the reasons that the trials were conducted by engineers of the highest standing with a thoroughly competent scientific staff, and the experiments lasted long enough to make sure that the results were really fair averages, and not, as is too often the case, unusually good results due to too short a trial and skilful jockeying.

It has been mentioned that forced draft was applied to the boilers of certain United States naval vessels during the civil war. It began to be used again in the 80's, this time in the English navy, and shortly afterwards in all other navies. There was a great demand for high speeds, and the boilers as then built took up so large a percentage of the room that to have continued to use natural draft alone would have made it impossible to put machinery in the ships to give the necessary high speeds. In the early stages of the use of forced draft it was confidently expected that an increase of power of at least fifty per cent. might be expected without trouble, but experience soon showed that when the boilers were driven to this extent there was trouble from leaky tubes. It was also found, as might have been expected, that the cost of power was materially increased. The reason, of course, was

that the amount of heating surface which could be provided in cylindrical boilers of the ordinary type was not sufficiently great to absorb the heat when the coal per square foot of grate per hour was raised from about 16 to 18 pounds under natural draft to 40 to 45 pounds under forced draft. I shall discuss this question of the effect of forced draft on economy more fully under the next division of the subject—"The Triple Expansion Engine."

In discussing the question of economy in marine engineering the matter which has just been referred to is an important item because the weight of machinery is a very important element in the general economy, and, dismissing the great reduction in boiler weights for the moment, I may refer to what occurred to the engines about the same time that forced draft was reintroduced. The notable feature here was a great increase in the rotational speeds. This is sometimes spoken of as "increased piston speed," but when the increase consists in a greater stroke in the engine without any change in revolutions there is not a material decrease in weight. When the change consists in an increased speed of rotation, we not only have smaller cylinders but smaller moving parts and smaller shafts. It has already been intimated that a part of the increase in rotational speeds was due to better material and better workmanship, but the really vital element is one which has not hitherto been mentioned. This was a correct understanding of the design of the propellor.

As with so many other things, the history of the propeller shows a progress from a very crude form, where the instrument was designed simply to accomplish results without much regard to the cost, up to the stage where refinement of design and questions of economy are of much greater importance. It is an old story that in the early days of screw propulsion a very large number of blades was used, and it was due only to the happy accident of some of the blades of a certain propeller having been knocked off that it was found that so large a number was unnecessary. It came to be the settled practice along in the 70's to make the diameter of the propeller as large as would be fully immersed. This was the basis from which the other dimensions were determined. The pitch was a nearly constant multiple of the diameter, and then a certain portion of a full convolution (about three-tenths) was taken and divided into four blades whose corners were slightly rounded. Such a method of designing necessarily made the engines driving such propellers of relatively low rotational speed and consequently quite heavy. When the demand for higher speeds came, able engineers began to investigate the design of the propeller, and it was

found that the method used had been entirely wrong. The propellers were altogether too large in diameter and had too much surface. It was finally discovered that, within reasonable limits, the design of the propeller is very elastic and that the engine speed might be determined to suit the conditions with respect to space and weight desired, with the assurance that a suitable propeller could be designed to give efficient results. We shall later on give a table showing the progress in economy of weights of machinery as well as of the cost of power, and it will be seen that in the high-speed engines, particularly those of torpedo boats, there has been an enormous reduction in the weight of the engines in spite of the fact that the modern engines work with a very much higher pressure than was used in the early days.

The Fairfield works which, under Elder, had been the leaders in the introduction of the compound engine, continued to build notable examples of them, and the largest and finest compound engines ever built were probably those in the Cunard steamers Umbria and Etruria, which work up to over 14,000 horse power. In them the steam pressure had risen to about 110 pounds. The high-pressure cylinder was 71 inches in diameter and each of the two low-pressure cylinders was 105 inches in diameter, the stroke of all pistons being 72 inches. Even when they were built, the next great change in the marine engine had commenced, so that steam pressures then jumped from 110 to 150 pounds.

The engineers who had led in the improvements which took place during the compound-engine period had good cause to feel proud of their work. While the next change which took place brought in a new name to designate the new engine, the change this time was one of degree and not one of kind, as had been the case in the change from the simple to the compound engine. The important features of high steam pressures, a moderate total expansion divided among the cylinders so as to prevent too great a temperature range in any stage of the expansion, high rotational speeds, the cylindrical boiler, forced draft, and the intelligent design of the propeller—all had been worked out. Progress during the next period consisted mainly in development and refinement of the principles which had been established during the compound period, as will be shown in the next article.

THE PLACE OF THE MECHANICAL LABORATORY IN THE EDUCATION OF THE ENGINEER.

By J. Boulvin.

There is probably no one subject to which the attention of the engineering world has been drawn more forcibly of late than the necessity of making technical education more practical in its nature, by the use of experiment in connection with instruction.

Professor Boulvin speaks with the authority of one of the ablest educators on the Continent of Europe, and both English and American engineers may profit by his experience.—THE EDITORS.

ENGINEERING education is a subject upon which much excellent matter has been written, but one which is never exhausted. Ideas upon such a subject can never be absolutely fixed; in proportion as industrial processes are perfected and as new sources of wealth are exploited, in proportion also as science progresses, as the boundaries of the world are modified, as financial or commercial aggregations vary and in their turn exercise an influence upon production, it becomes impossible for the engineer to preserve a stationary position among these evolutionary surroundings.

No type of education can be established that will be responsive to all needs, because these vary with situation and time. All that can be expected is a statement of major principles, based upon a sound acquaintance with the subjects of education and the psychology of the student. In establishing a course of technical instruction it is needful also to take into account the nature of anterior or preparatory teaching; the authorities of an engineering institution have little or no influence upon the general methods of instruction in schools of primary or intermediate grade. It follows that a system recognized as excellent in France could not be applied with success in England or the United States, and *vice versa.*

It should be noted, however, that much general progress has been made in the establishment of mechanical laboratories.

I think I do not err in stating that the first installations of this kind were made less than a quarter-century ago. Before that the course of instruction for engineers consisted solely in the study of mathematics and in such sciences as physics, chemistry and mechanics. It was completed by the application of these sciences to the diverse branches of applied mechanics, such as hydraulics, strength of materials, machine designs, etc. The sole practical exercises were problems or plans of fixed structures or machines.

It is undoubtedly true that all fixed construction work is based

upon the principles of the equilibrium of forces, and that by the theoretical method the design of a structure such as a frame-work may be fully determined. This is a branch of study that will ever remain fundamental and which, consequently, can never be neglected.

To solve correctly all the problems of this kind presenting themselves in construction the only incentive necessary is that furnished by numerous examples. Here experience has but little influence, for mechanics is a science of which the results are as positive as those of geometry; from its conclusions there can be no escape. It would be a dangerous illusion to fancy that one might pass by the study of theoretical mechanics, and the mathematical knowledge needed for its understanding and use.

In this connection it is worthy of remark that the mathematical training of engineers should be specialized with reference to their objective aims. Mathematicians will not fail to raise to this the objection that as there is only one kind of mathematics, maintaining that there can be no question of difference, save as to degree, between the training of an engineer and of a doctor of sciences. I think that this constitutes a positive error. The academician, who cultivates pure mathematics for its own sake rather than for its applications, may content himself with very general theories regardless of their applications. The student who can give his entire lifetime to mathematical investigations, has no need to follow out the ultimate results of all his studies; what he needs above all is a clear general view of the methods of the sciences, and of the profound relations that exist between them.

But with the engineering student, who works at his mathematics for its immediate utility, all is different; if he is not able to use his mathematical training from the moment of his entrance upon the technical side of his profession it will ever remain a useless tool in his hands, for he will never find time in his active career to perfect that knowledge sufficiently to use it with confidence. It results that his mathematical training should be at once less extensive and more profound than that of his fellow; more profound because he should be able to apply it without deceiving himself with errors in numerical examples. I constantly observe good students, coming from mathematical classes in which they have distinguished themselves, committing deplorable errors when they try to apply their mathematics to very simple physical or mechanical problems. Habitual combination of mathematical symbols has made them lose sight of the quantities the symbols represent, and they are not always enlightened by the absurdity of the solutions at which they arrive.

I believe that, as a general rule, the best results are obtained by curtailing the extent of mathematical courses and in requiring students to solve a larger number of numerical and practical problems; but by this I must not be understood to say that the time devoted to mathematics needs to be made shorter.

From various sides there has been recognition of the insufficiency of polytechnic instruction. In the case of fixed structures which must be sustained by the strength of their members, it is of course essential to know the stresses that will be developed in these members when the structures are erected; but it is also important to be informed of the capacity of the materials to bear these stresses securely. In the case of machines, and especially complex machines, such as those which accomplish the transformation of heat-energy into work, the hypotheses are always so far away from the facts that the deductions should be supported by experiment. The conversion of heat-energy into work rests upon the laws of thermodynamics, as immutable as those of gravitation; there is nothing arbitrary in Nature's processes; but the knowledge of the data necessary in applying these laws can be reached only by experiment.

We owe our knowledge of the properties of steam to experimental labours of which the importance and exactitude have never been surpassed. However extended the admirable researches of Regnault had been, that *savant* could never doubt that they would become insufficient at some time. Even to-day we are lacking in absolutely certain data for the properties of steam at very high pressures, and especially for superheated steam. Such researches must necessarily be of a very high class; it is not to be thought that they could be undertaken or repeated as a matter of course in all laboratories. Such a task demands the work of some physicist of high talent and reputation who can bring to the technology of the steam engine the fundamental data it is beginning to need.

In the study of steam engines the part of secondary or dependent phenomena is important. The conductivity of cylinder walls has an especially notable effect, yet it is still almost impossible to calculate it, notwithstanding the remarkable researches which have already been made, notably by the French engineer Nadal.

The state of our knowledge as regards the steam engine is, then, as follows: Theory teaches us several important facts which cannot be discarded without inviting serious errors; the study of its details has been carried far, steam distribution being notably a subject which can be taught so perfectly that a good student should be as much at

home in it as would the late Mr. Corliss himself; but at the same time it is practically impossible to calculate with any certainty how much steam will be consumed by an engine working under given conditions. Experience alone can answer this question.

But it is not only the study of the engine which is found in this situation; in all the phenomena of applied mechanics there are unknown elements. It is the business of the engineering laboratory to search out laws as yet unknown, to verify those which are more or less uncertain, and to record by experiment the results of theories having a mechanical or physical bearing.

The mechanical laboratory presents itself thus as an auxiliary indispensable to theoretical study. The utility of this modern appendage of engineering schools is so evident, so incontestable, that it has been recognized in all countries endowed with technical courses of instruction. Like many modern ideas, the mechanical laboratory had its birth in the United States; it was almost immediately developed, though not so amply, in all parts of England, and more lately in Germany and other countries.

While the laboratory is indispensable for the fruitful study of applied mechanics, it should not be concluded that it can suffice for all, that it can be substituted for theoretical instruction, that the engineering student will hereafter pass all the time allotted to his instructions wearing overalls and amongst machines, for no idea could be more of a mistake.

Experiment has no inherent value if it is not susceptible of generalization. Whoever should have shown by experiment that the square constructed on the hypothenuse of a right triangle is equal to the sum of the squares constructed on the other two sides would not have advanced our knowledge, until the moment arrived in which he might have demonstrated that this property is true for all right triangles, whatever their size or form.

What is of importance to science is the interpretation of experiment, the generalization of conclusions that may be drawn from it, the culling from it of material that may be erected into more general or more exact theories. Hence laboratory work is not destined to invade the place in schools now given to sciences hitherto taught and thought indispensable; it will never be possible, in my opinion, to train a civil or mechanical engineer without a knowledge of mathematics, physics, and theoretical and applied mechanics, and the more complete this knowledge, the better will be the product. Laboratory researches are destined to give to the theories of applied mechanics the basis upon

which they must rest. They, alone, can give this science its true significance.

This is a very important result, which might be partly attained if only the professor devoted himself to experiment. His teaching would gain in precision and authority, he would inspire more confidence than if he applied his instruction to experimental work done by others, frequently under different or unknown conditions.

But this is not enough; applied mechanics cannot be regarded as a science to be swallowed whole, which a young man can learn once for all in order that it may serve him through his entire career. Altogether different from the exact sciences of which algebra and geometry are types, it is in a continual state of transformation, a science that is never finished and that each engineer should himself help to bring up to date and modernize. The employment of new materials of construction for cylinders, and perhaps even a simple modification of the physical condition of surfaces exposed to steam, would doubtless sensibly alter their power of heat absorption or emission. The appearance of new lubricants or new alloys might modify the laws of friction. The result of these facts, quoted only as insignificant examples, is that the engineer should use, not only while at school, but all his life long, a faculty of vigilant observation. No success is possible for him unless he is accustomed to give the experimental side of his profession its full importance.

Doubtless the experiments which can be made at a school will always be limited in number; if one studies only the deduction to be drawn from them he will have a scanty equipment for encounter with the pitfalls that beset an engineer's career. But the real scope of such work is much wider. What he really should learn is the method of experimentation, that is, the art of making exact experiments, the necessity for employing apparatus, an appreciation of the importance of little things. Possessing these aptitudes he will be ready in his practical work to address himself to experiment whenever he needs it and to do this with a continually increasing ability.

Naturally, there arises the question as to what researches should be made in a mechanical laboratory to produce the greatest sum of usefulness. In principle there is no limitation to these researches save that set by the equipment of the laboratory itself. However, it is evident that the student, except for rare exceptions, can take up new and original research only with difficulty; the time he can pass in the laboratory serves only as an introduction to the fundamental experiments.

Thus, regarding strength of materials, the coefficients of elasticity

of a number of specimens, chosen best to exhibit their differences, would be measured.

In the case of machinery the field is much more extensive; the steam boiler alone furnishes occasion for experience in the methods of testing combustibles, of studying steam production, and in consequence the importance of controlling the progress of combustion by gas analysis, of verifying the quality of the steam produced, etc. Delicate calorimetric operations and high temperature observations included in the course of these experiments are types of work eminently proper for the development of the student.

With steam engines, the determination of power by means of the indicator or by brakes, simultaneously with the measurement of the steam consumed and the heat lost, constitutes a programme of illimitable scope. If the engine is arranged to operate under different conditions, as a laboratory engine should be, the experiments may be made particularly interesting, since they permit the study of the influence of changes in the conditions of running. There is nothing more suggestive than the investigation of the results of such comparative tests, as exhibited in entropy diagrams. These tests can be repeated, one condition being changed at a time, for example, the pressure, the cut-off, the speed, etc.

The gas engine lends itself to the same class of researches, including the influence of the composition of the explosive mixture, of the degree of compression, of speed of running, of temperature of the cylinder, as well as of the method of ignition.

Pumps, fans, air or gas compressors, all give opportunities for varied experiments, either concerning their efficiencies or their working. Hydraulics, and the apparatus belonging to it, furnish other types of researches which can be carried on in a laboratory where a natural or artificial head of water is available.

Besides these experiments, so interesting from the educational point of view, there are others of much importance of a more theoretical nature; for example, I may cite those which may be made upon the flow of fluids in general, and of steam and water in particular. It is impossible to foresee exactly along what lines the prime movers of the future will develop. Many predictions made in this regard have failed and I shall not hazard one more, but it is certain that the increasingly frequent employment of superheating and the large place already taken by the steam turbine are facts wherein industry has outstripped science; it belongs now to the latter to furnish practicians the necessary data for the further knowledge of these applications.

By these small indications, for I cannot undertake in so limited an article to describe in detail all the desirable functions of the mechanical laboratory, it may be seen that the educational value of experiment is varied and extensive. The generation that follows us will hardly believe that schools without laboratories could have existed.

I do not think the research work of students can be expected to enrich science, considering the time spent upon their studies, which is generally three years in England and more frequently four years on the Continent of Europe. For the student, then, the experimental teaching must be considered as a sowing of seed to germinate later, and to aid him in accomplishing his end with greater profit both to himself and with benefit to the public.

The mission of the professor is to devote himself to research work of a more special and fundamental character, for, beside the obligations of teaching, it is his duty to aid in the advancement of science. This is important, and I may be permitted to indulge in some reflections:

The professor, I speak now of European countries, is too completely absorbed in the duties of instruction; there are many *savants* whose ingenious spirits have been stifled by the too prolonged labors of a fatiguing professorship. One can scarcely believe, unless he has been himself a professor, how depressing is the work of preparing lectures, correcting exercises, studying new projects, and above all the periodical examinations which are scholastic traditions. This work absolutely must be done with zeal and perseverance; the professor must set an example of care, of method and of correctness to his pupils, themselves at the age when these qualities are most often lacking.

These professional tasks absorb all a man's energies, and I know of more than one who looks joyfully upon the approach of vacation season, not that he may profit by his well-earned rest, but that he may work in peace at his personal researches.

This state of things cannot be true everywhere. The great American schools, notably, enjoy the privilege of being able to manage their own affairs; I like to think that they do it with much intelligence. And I exaggerate nothing in saying that in certain European countries where the technical schools are dependent upon the government, the life of a professor may be somewhat irreverently compared to that of a cab-horse; it is overburdened by the multitudinous detail of a teacher's duties.

Does it conform with the general interest and with good returns on the moneys invested in technical schools so to abuse the man upon whom rests so high a mission? Evidently not. There should be a

remedy for this situation. It is needful that lessons be given, with all their retinue of exercises, examples and examinations; but this task ought not to be prolonged too far, it would be entirely reasonable to arrange, say, after twenty years of professorship to give the surplus work to a younger man as successor, for whom, incidentally, this preparation is necessary.

The professor would cease his daily and fatiguing teaching, at an age when he would be in full possession of all his scientific faculties, and consecrate himself thenceforth exclusively to theoretical and experimental research. He would do his work with the maturity acquired in the first stage of his career; he could then use the time that these researches would demand.

Experimental work of a purely scientific order can be done only by a professor, who has a wide view of the problems of which so many yet remain for solution. The domain that remains to be covered is vast, and it may be enlarged at any moment in an unforeseen manner. It would be rash to attempt to indicate what researches should be ununderstaken at present, when new and fruitful openings are daily made by men of science. Thus, the thermometry of high temperatures has made a great step in advance by the invention of the thermo-electric pyrometers of Professors Callendar and Le Chatelier; many problems we would not have dared to face twenty years ago are susceptible of solution; the measurement of the variable temperature of the metal of engine cylinder walls at all depths has been conceived; the temperatures of explosion and of exhaust in gas engine cylinders have been measured. It is indubitable that before long, and by the use of these new instruments of research, we will come to a clear vision of the truth in phenomena long discussed, those that have given rise to so many suppositions and probably to so many errors.

The problem of engine regulation itself, old as it is, and one that might have been thought sufficiently solved, leaves the door open for new researches. Operation of polyphase electric generators has increased the requirements of regulation in prime movers to such a point as to necessitate a more complete study of the methods of operation of governors. It is no longer sufficient to take account of mean speeds as they might be registered by a tachometer, but to study the speed of the fly-wheel rim at each instant of its revolution by means of the isochronous vibrations of a tuning fork.

There is still another point of view from which the laboratory may be regarded, for it is frequently called to the assistance of industry; it is becoming more and more true that the latter can prosper only

by an intimate accord with science; empiricism is disappearing before better research and more perfect products. The modern manufacturer, whether he be smelter or engine-maker, concerns himself with daily measurements for which his works are the proper laboratory; thus the engine-builder constantly measures and compares the efficiency of his output, for it must be kept at the salable standard. That which is not now a necessity in a new and rapidly expanding country is an accepted fact in lands where industry is an ancient foundation; an engine of any importance cannot be sold to-day in Germany, Austria, France, Belgium or Switzerland without a guarantee of its efficiency. This state of things will become general, a reason for satisfaction because it is only reasonable that the prices of things should be determined by their quality; in default of this basis of rational appreciation there are only the arbitrary claims and misleading statements of commercialism.

Outside of the current experimental work carried on by the personnel of works there are special researches which require costly instruments or exceptional aptitude and which, for these reasons, can be pursued only in a true laboratory. There is also a category of experiments which bear upon questions of public safety and which are indispensable to governments. Now when one sees steam boilers put under inspection and measures imposed upon the circulation of vehicles in streets and roads, it is natural to think that the administrations have the right to intervene in many cases where human life may be menaced.

I shall not discuss the question of whether it is preferable for the State to exercise its action in a preventive manner; that is, by imposing regulations. Many people are of the contrary opinion and these regulations may have objectionable features; not their least inconvenience is that they age rapidly, that they soon become out of accord with modern exigencies and that then they hinder progress. But if the preventive action of the state is not always exercised the same thing is not true of its repressive action, for the courts are called upon to pronounce in cases of accident to persons or injury to property. Should the case be the explosion of a receiver, the collapse of a structure, the breaking of a cable or a bridge, it is most often a question of material that is concerned. Almost invariably the inquiries to be made to establish responsibility are of an experimental character, which may be made with competence and impartiality in a mechanical laboratory. Experiments of this class are instructive for everybody, since they apply to materials such as are in actual use, submitted to the fatigues

and stresses of their proper employment, and not placed in ideal or artificial conditions.

The laboratory can, then, be usefully consulted under many circumstances and it becomes thus an institution of public interest. Is it proper to attribute this last function to laboratories of technical schools, whose mission is already so important, or would it be better to build for this purpose special establishments directly under governmental authority? This is a question of occasion which cannot be answered in a general manner. If the laboratory has a sufficient personnel at its disposal there would be, perhaps, no great inconvenience in the execution of experiments demanded by particular occasions; there might even result certain advantages through the greater variety of researches and by the more frequent contact of the professors with industrial conditions.

However, we may conceive of a central laboratory in a country, established to respond to the demands of particular occasions, of municipalities, great railway companies, etc. This is almost precisely what has been done in Germany, where the Reichsanstalt at Berlin responds to these exigencies.

It is scarcely necessary to resume and to conclude. The *raison d'être* of mechanical laboratories is that they are destined to exercise a great influence upon production and upon the public wealth. This influence they exercise in three different ways, all concurring to the same end: First, by the better, more precise and more useful education they give young engineers, into whom they instil the necessity for experimentation and to whom they give a practical turn in thought and habit; again, by the opportunity they afford professors to give themselves over to the researches necessary for the advancement of science; finally, by the direct help they give to industry in undertaking the various investigations it demands of them.

To respond to these various demands the laboratory should necessarily be furnished with a varied and complete equipment, but the attention given the material side of things should not close our eyes to the qualities necessary in the men who will frequent it or guide its destinies. For the students there is requisite with sufficient theoretical instruction, a great desire to learn and an awakened curiosity; for the professor a great love of research nourished by profound scientific knowledge, and time to devote to it. Experience with existing laboratories demonstrates that these conditions are fulfilled to a high degree, for they have rapidly taken a large place in the profession of the modern engine, and this place will surely rise in importance.

THE FACTORY OFFICE.

CONSIDERED AS A PRODUCTIVE DEPARTMENT.

By Kenneth Falconer.

Mr. Falconer's timely contribution to our discussion of management problems makes a fitting addition to Mr. Carpenter's series of excellent papers publishing currently.

One of the chief difficulties in connection with a satisfactory system of shop-accounting is found to lie in the proper discrimination between the direct productive departments and those which must be considered as a part of the general expense account. Mr. Falconer shows how the factory office may be separated from the general system of accounting, and so be capable of inclusion in the productive shop work portion and distribution throughout the output in a manner similar to other shop costs.—THE EDITORS.

N view of the fact that clerical and accounting work is almost universally regarded as non-productive work, the application to it of the principles of economical production would at first sight appear impracticable, and a proposition to regard the factory office as a productive department of a manufacturing business would seem illogical and absurd.

A consideration, however, of the true objects of factory accounting, of the results expected from it, and of the valuable uses to which such results may be put, gives some weight to the claim that the output of the factory office may readily be one of the most valuable products of the concern—even though it has no marketable value.

Besides obtaining the correct cost of each and every article manufactured, a proper system of factory accounting should secure to the management full information as regards all the internal accounts of the business, whether such accounts represent assets or liabilities, receipts or expenditures, and such changes and fluctuations as these accounts may show from time to time. More important still, it should plainly indicate the causes of any such changes whenever they may become unusual or abnormal. This information should always be a matter of current work and not of past history, and should be so promptly secured and recorded in such manner as to facilitate comparison with past records of similar operations or transactions. Thus promptly secured and systematically recorded it will enable most val-

uable conclusions to be drawn from it, and judicious decisions based on it. The office of any manufacturing business attaining these results and turning out work of this kind is very far from a "non-productive department." Upon the management rests the responsibility of putting such results to the wisest use as truly as the responsibility of putting to the best use any part of the equipment or of selling to the best advantage the output of the shops.

In applying the principles of economical production to work of a clerical nature, a glance at what such principles involve and at the chief conditions which make for or against economy in the shops may show how best to apply similar principles and regulate corresponding conditions in the office.

In planning for the manufacture of any article the object sought is to obtain the desired product with the least possible expenditure of material, wages and time, the latter very possibly the most important item of the three. In the case of day work, the wage-cost itself is, of course, dependent on it, and of the many other factors affecting cost of production the majority vary more or less directly with it. On how wisely time is used, how little of it needlessly expended to say nothing of being lost or wasted, depends greatly the success of the shop as a productive concern.

The best use of time is largely dependent on a judicious apportioning of each job or class of work to the man or machine best suited to handling it, and this again is closely connected with the question of as far as possible, having all work done by the cheapest man or machine competent to perform it—the cheapest not necessarily meaning the lowest priced, but cheapest in view of rate of wages paid, time consumed, and quality of work done. Economical production and cheap production are entirely different things.

There are many other factors which tend for or against the efficiency of a shop, and consequently its cost of production. Some are more and some less prominent, but they nearly all hinge on the question of time. The more important of these, on account of their prominence, are usually pretty closely watched by those interested. Others, small in themselves, but which may yet have important results, often on account of their familiarity "pass unrecognized, or where not entirely ignored are apt to be so grossly underestimated as to be thought of very little account."*

In the factory office as in the shop, the "cost of production," (or ob-

* "Neglected Factors of Machine Shop Economies," by T. S. Bentley, in THE ENGINEERING MAGAZINE for January, 1902.

taining results) is largely a question of judicious supervision, and modern and complete equipment. In the former as in the latter there is great danger of overlooking or neglecting many matters whose importance is more real than apparent, and in the one as in the other time is the paramount consideration, most of the others being more or less important as they may affect it.

That is not a good foreman who neglects the supervision of his shop in its smallest detail to do mechanical work which can be done by a workman, but that perhaps is the mistake most frequently made by those in charge of what may be termed the technical accounting of a manufacturing or industrial concern. It must be remembered that "factory accounting" is not ordinary book-keeping, and that it is very much more than a branch of the science of accounts. While subject to the laws of accounting it is largely affected by consideration which the ordinary accountant never meets nor requires to study. The time is coming when it will be recognized as a profession in itself, partaking somewhat of the nature of both engineering and accounting.

If prevailing conditions justify the employment of a factory accountant they necessarily justify the employment of a sufficient staff to leave his time free for work which he alone can do, otherwise it is a clerk that is required. Though as a rule clerical work does not require such close supervision as mechanical, yet the clerical work of a factory office being so different from that of a commercial or mercantile office the rules usually prevailing in the latter must be modified to suit the former. I do not mean that the factory accountant should do no work, but I do claim he should do no routine work. His time may be and should be much better employed, even though he apparently does less actual work than any of his clerks.

If the conditions justify the making and filling of such a position as factory accountant, in order to obtain the best results it is quite as necessary he should have entire control of his department, as that a foreman should have full control of his men. This is a claim of which most managements fail to see the justice, virtually taking the stand that the factory office is part of the general office, instead of an entirely distinct department. Like the foreman of the shop, the factory accountant must study and know his staff—the capacity and temperament of each, and distribute the work accordingly, being careful as far as possible to have the services of each clerk employed on the most important work he is capable of doing. His clerks' brains are his productive plant, and it is far from economy to have a machine of high cost and value doing work which can be done equally as well

and in the same length of time by one representing a smaller investment.

In the factory office, even more than in the shop, is the question of discipline as regards time a difficult one. In the latter men can be and usually are held pretty closely to their hours by a system of locking out for a part of the day and a consequent loss of pay. In the office such a plan is impossible, but, nevertheless, discipline and punctuality are quite as necessary as in the shop. In office work there always must be a certain amount of give and take, and fairly treated, the average clerk will be disposed to act fairly. As in the shop so in the office, except under exceptional circumstances, any advantage gained by working overtime is more apparent than real. When it is necessary, however, clerks will usually be ready and willing to put in the extra time, provided they know that the management see and realize that it is an extra effort that is being called for. Where clerical work is not kept up to date, nine times out of ten it is the fault of those in charge, not of the clerks, and in the majority of cases the cause is neglect of thought and care in distributing the work and planning the details. Where, when required by exceptional circumstances the staff refuse to make an extra effort, or do so unwillingly (and as a result ineffectively) it is either because the call for such extra services might by a little foresight have been avoided, or because they are asked and expected as a matter of course.

In these days a shop cannot turn out product at a cost low enough to meet competition unless fitted up with modern equipment. Similarly any factory office not supplied with modern appliances will be unable to procure and record the results looked for until the value to be obtained from such results is greatly decreased. A monthly statement of all details and results is valuable in direct proportion to the promptness with which it is prepared. Its value lessens greatly with each week or even day that elapses between the month to which it refers, and the date it is available for study or use. Comparisons of cost of manufacture to be of the greatest use should be obtainable as the work progresses, not as is often the case so long after completion that they have partially or completely lost interest and value. It is in this connection that a thorough knowledge of card and loose leaf systems is of use, and only those who have made a study of them can realize the great saving of time that may be effected by their use.

The lesser questions, light, heat, ventilation, &c., which Mr. Bentley points out in the article already quoted as affecting the question of economical work in the shop, also directly affect the cost of office work.

As a general rule it may be said that anything that tends to make a workman or a clerk more interested in his work—more comfortable in his surroundings, or more in harmony with his fellows, tends to lessen the cost of the workman's product, or of the results obtained by the clerk's labor, in other words to reduce the cost of production. Even in such a small matter as the location of the desks of the various employees, convenience should be studied, and as a result time saved. These and similar matters, admittedly small in themselves, may collectively affect the question of time, and therefore of cost of production to a greater extent than will readily be believed.

A factory office, looked to for important results,—expenses of operating it regarded as its cost of production,—the information and records it procures looked upon as its product,—is the fairest and most legitimate view to take when considering the question and the cost of factory accounting. That its product has no market value, and that its worth to the management cannot be expressed in figures does not disprove the claim that the factory office is a productive department.

HIGH TENSION ELECTRIC POWER TRANSMISSION.

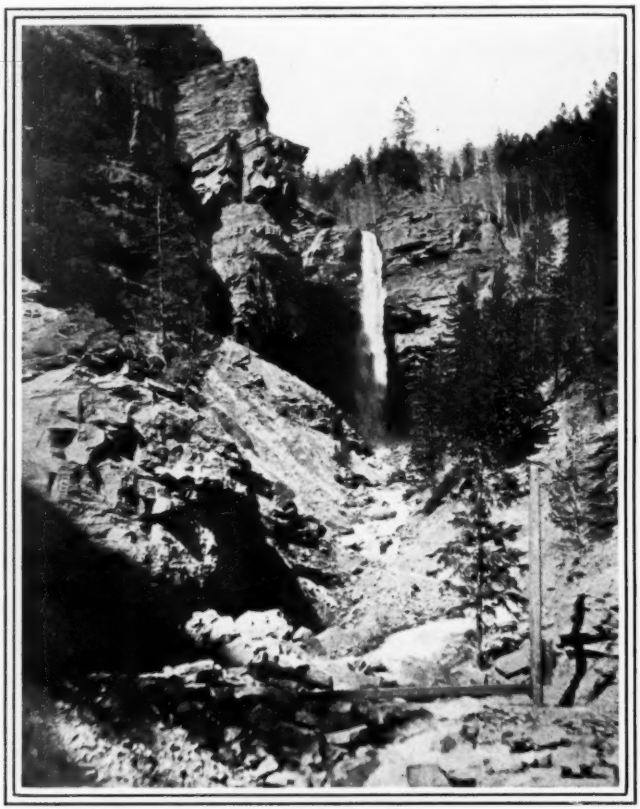
By George H. Gibson.

The use of electricity for the transmission of power has proved one of the most potent factors in the utilisation of the forces of nature for the benefit of mankind, and every improvement which extends the range of that transmission comes as an added resource to the wealth of those favored localities in which natural power is available. Mr. Gibson shows the progress which has been made in the electrical transmission of power during the past ten years, and the story cannot fail to be of interest to engineers and laymen alike. —THE EDITORS.

NGINEERING has been defined as "the science of making money go the farthest." Considering another aspect of the subject, we may say that it is the science of making investments of money earn the most interest. Financial possibilities must always be important and determining factors when considering proposed engineering undertakings, and this applies with especial pertinency to the present subject.

When power is needed for manufacturing or other purposes the question usually arises whether it will be more economical to generate the power at the place where it is to be used or to transmit it from some distant and cheap source of energy. This question must be solved always upon the merits of the particular case, but in order to give the most satisfactory answer the very latest developments in the art of power transmission must be taken into consideration. The capitalist, and even the engineer who is not a specialist, is apt to base his calculations upon the successful practice of five or six years ago, rather than upon the demonstrated possibilities of to-day. It is the purpose of this article to exhibit, by citing some recent and successful installations, the latest progress in high-tension electric power transmission, and to draw attention to the ruling conditions in this branch of engineering.

It is now ten years since the historical Frankfort-Lauffen experiments, when 300 H. P. was transmitted more or less successfully over a distance of 100 miles by means of three-phase, alternating currents at 30,000 volts. Although these experiments were confirmed in the following year by the practical operation of a thirty-mile, 10,000 volt



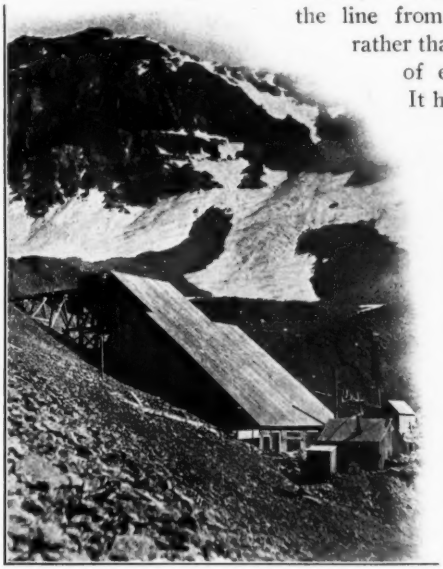
DISTANT VIEW OF CONECT FALLS.
These falls furnish power to the Tomboy Mining and Milling Co., Pandora, near Telluride, California.

line at Pomona, California, subsequent progress in the application of high potentials was very slow, nor was this slowness entirely due to the natural hesitancy of capital in entering a new and unfamiliar field of investment. Early experience with high voltage currents inspired caution as well as respect. To handle a voltage capable of leaping a spark gap of several inches, and which would in time break down even the best insulation previously used successfully with lower voltages, required not only intelligence and care, but some rather costly experimenting.

But it may be safely said that the period of experimentation is

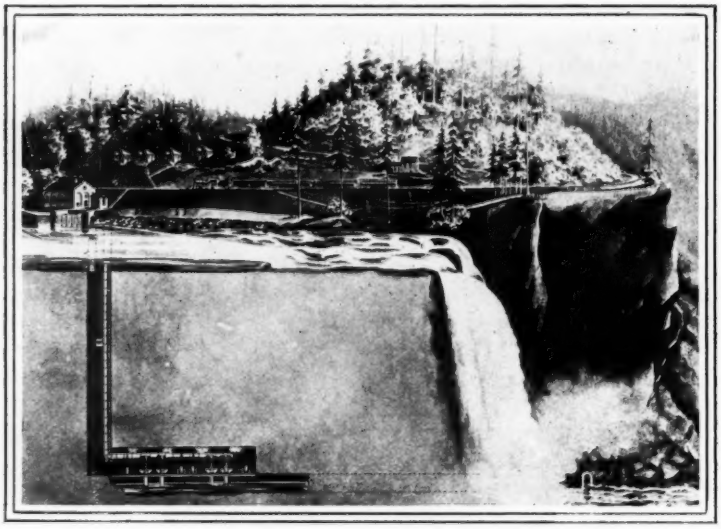
over and high voltage undertakings may now be entered upon with entire confidence as far as the technical side of the question is concerned. In the words of a prominent engineer: "Apparatus as now constructed permits the use of 30,000 volts with practically no more risk of break-down than was involved in the use of 3,000 volts in 1890. This means that in ten years the increase in practical potential has multiplied the range of transmission by ten and the area of the territory within range of cheap water power by 100."

The voltage of transmission has been so much increased that the great loss of energy permitted in some of the earlier lines is now avoided and electric energy may be transmitted for 30, 40 and even 50 miles at an efficiency of 80 per cent., and without a prohibitive cost for copper. At 50,000 volts, 50,000 HP. may be transmitted with a loss of $^1/_5$ of 1 per cent. per mile and at a cost for conductor of only about $5,000 per mile. In fact for comparatively short distances, as 20 to 30 miles, the voltage which may be used is far above the requirements of the most economical transmission. The size of the wire in such instances, unless a very large amount of power is to be transmitted, is determined by the durability of the line from a mechanical standpoint rather than by considerations of loss of energy or cost of copper. It has been found that it is inadvisable to put up wire much smaller than about No. 6 B. & S. gauge, since smaller wires are liable to breakage.



BELMONT MILL, TOMBOY MINING AND MILLING CO., PANDORA, CALIFORNIA.

However, it is still true that there is a quite definite maximum limit to the distance over which power may be economically transmitted, even though the cost of the power may be practically nothing at the point of generation and coal may be very dear at the point of distribution. But this dis-



THE SNOQUALMIE FALLS POWER PLANT.
Sectional view, showing shaft, power house and tunnel.

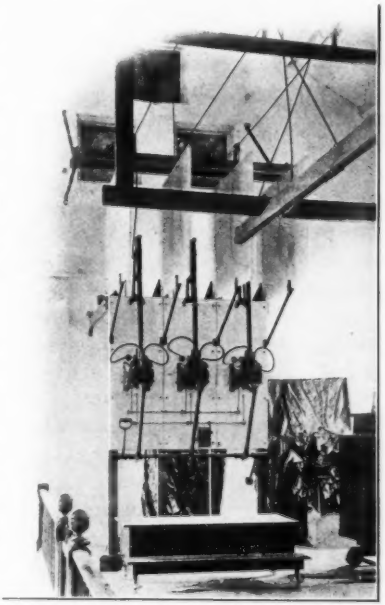
tance is much greater than is usually supposed. The distance that may be covered by a transmitting line having a given weight of copper varies directly as the voltage employed. If we assume three miles per thousand volts and the loss of energy in the line at 16 per cent., the cost of the copper is about $20 per HP. This permits a range of transmission with a very good efficiency, both from a power and economic standpoint, of between 100 and 200 miles. Above this limit, however, there seems little prospect of passing. Three miles per 1,000 volts requires 50,000 volts to cover 150 miles, and 50,000 or 60,000 volts is at the present time the practical limit for the transmission of electric currents over bare aerial conductors. At higher voltages the air ceases to be a good insulator; it "breaks down" and acts more like an electrolytic conductor. This results in the passage of a very large amount of electricity through the air from one wire to another and a consequent loss of energy. It would be possible to build transformers and to manufacture insulators to withstand a much higher voltage, but the physical properties of air impose here a definite limit unless we enclose our wire in insulating tubes, a practicable form of which is yet to be devised.

Another point in this connection is that while it may be feasible

and profitable to transmit a large amount of power over a long distance, it would be impracticable to attempt to transmit a small amount of power over the same line. This also follows from the physical and electrical properties of the materials we have to deal with. The charging current of a line designed to transmit 100 HP. is about as much as that of a 1,000 HP. line. This charging current, which becomes considerable with high voltages and long lines, transfers no energy but requires proportionately as much capacity in the generating station as the useful current transmitted. It also gives rise to loss in the line and affects to a considerable extent the voltage regulation.

We will now take up some of the recent and more noteworthy examples of high-tension power transmission. One of the most striking of these is the Snoqualmie Falls plant in the State of Washington, from which power is transmitted 31 miles to Seattle and 44 miles to Tacoma. The transmission is by three phase current at 30,000 volts over a line of aluminum. This was one of the first places where successful use was made of aluminum as an aerial conductor.

The generating station at Snoqualmie is located in a chamber excavated in the rocks below the Falls. It contains four 1,500 KW. three-phase Westinghouse alternators, which generate current at 1,000 volts. This is transformed in a station at the head of the penstock shaft to 30,000 volts, three-phase, by oil-insulated, air-cooled transformers. Between the transformers and the line is placed a full equipment of non-arcing metal lightning arresters. While machinery for only 6,000 HP. has been installed the water power may be developed to furnish 100,000 HP. the year round. The climatic conditions at Snoqualmie are rather excep-



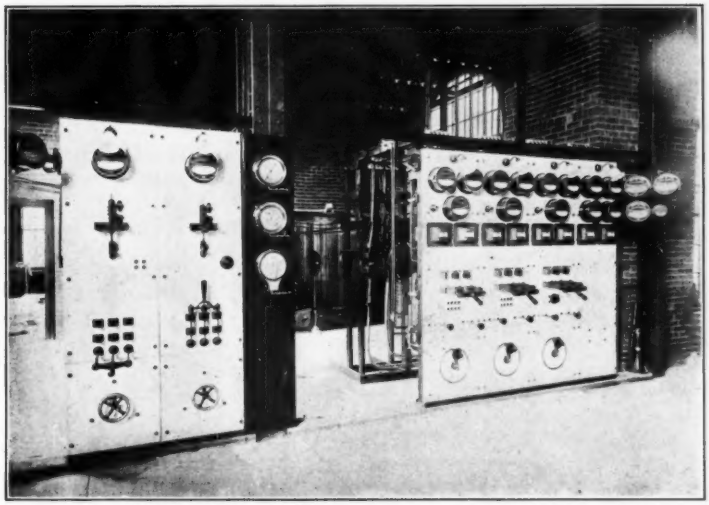
THREE HIGH-TENSION CIRCUIT BREAKERS.
Trade Dollar Consolidated Gold Mining Company, Swan Falls, Idaho.

tional. The catchment area is only about 600 square miles, but the average annual precipitation is nearly 90 ins. A large amount falling as snow during the winter months becomes available by melting during the months of drought, and it thus happens that the two months of greatest flow are November and June. The effective head on the turbines is 250 feet and the minimum flow of the river at present is 10,000 cubic feet per second. This, however, may be greatly increased by the construction of reservoirs in the catchment area. Tangential water wheels are used having ellipsoidal buckets and needle regulating nozzles.

This plant has been made the subject of some interesting experiments. The transmission lines to Seattle and Tacoma, which are double, were so connected up that the current passed from the Falls to Seattle, back to the Falls, to Tacoma and then back to the Falls again, making a total distance of 153 miles. The line was found to have a resistance of 241 ohms, and the resistance of the insulation from the wire to the ground was 7,000 ohms. One of the 1,500 KW. generators furnished the current sent over this circuit, and a similar machine was used as a synchronous motor at the receiving end. It was found possible to transmit a large amount of energy in this way with a loss of approximately only 13½ per cent. Tests made on open circuit to determine the charging current showed that the latter required in the generators a capacity of 112 KW.

The commercial success of this transmission scheme is well assured, both from a technical and financial standpoint. The towns of Seattle and Tacoma are rapidly growing, and have a population of nearly 120,000. There are also many neighboring towns in which current from this system is used for manufacturing and other purposes. The Company has decided to install three additional units of 3,000 KW. each and Mr. Charles H. Baker, president of the Snoqualmie Falls Power Co., has recently applied for a franchise to distribute power in Portland, 200 miles distant from Snoqualmie Falls.

A unique and interesting plant is that of the Compañia Explotadora de Fuerza Hidro-Eléctrica de San Ildefonso, consisting of five generating stations in the mountains 12 to 30 kilometers from the City of Mexico. The five stations contain 19 water wheels which are direct connected to the same number of 225 KW., 2-phase, 50 cycle Westinghouse alternators. The current is transformed from 440 volts, 2-phase, to 22,000 volts, 3-phase. The distribution in the City of Mexico is at 2,500 volts. The five stations are scattered over a considerable area of country, two of them being on one small mountain



THREE PHASE SWITCHBOARD, COLORADO ELECTRIC POWER COMPANY, CANYON CITY, COLORADO.

This plant supplies the Cripple Creek Mining district.

stream and three on another, but, nevertheless, the 19 alternators are operated in parallel. These plants will be reinforced by a 1,500 HP. steam plant at the receiving station and by storage batteries. The cost of coal in the City of Mexico is $22 per ton and upwards.

It has often been proposed to place electric generating plants near coal mines and distribute the energy to manufacturing districts by means of high-tension electric currents, but where there are reasonably good facilities for transportation it has usually been found more economical to ship the coal. However, there is one plant at least in the United States where this is not the case. The mines in the Cripple Creek District of Colorado are located in a country which is very difficult of access, and although there is coal to be had at no great distance, it is very difficult to transport it to the mines. Also, since there are many mines and it is more economical to conduct one large power station than a number of small ones, this was considered a good field for the electrical transmission and distribution of power. Another condition was that there was a scarcity of suitable water for steam boiler purposes in the Cripple Creek district.

The Colorado Electric Power Company was formed in 1897 to furnish power to the mines in the Cripple Creek district. The power

LUMBER CHUTE, FLUME, AND TRESTLE, MT. WHITNEY POWER CO.

station is located at Cañon City near the coal fields, where it is accessible to two railways and can also be supplied with coal by a down-hill wagon haul direct from the mines, which are owned by the company. The station is equipped with Hamilton-Corliss engines direct connected to Westinghouse 3-phase generators, delivering current at 500 volts and 30 cycles. These machines are rated at 470 KW. each. Three oil-insulated, self-cooling transformers raise the current to 20,000 volts for transmission over the 25 mile line to Cripple Creek and an additional transformer is kept in reserve. The line, which is over difficult mountain country, consists of three No. 3 bare copper wires arranged in triangle on glass insulators. Thirty-foot, white cedar poles are used and the standard length of span is 225 feet. At Cripple Creek the potential is reduced to 500 volts and the current is distributed to three-phase induction motors operating hoists, pumps, etc.

The Trade Dollar Mining Company, of Silver City, Idaho, has recently put into operation a large water-power plant at Swan Falls on the Snake River from which power is transmitted to the Company's mine 27 miles distant. The power house contains three Westinghouse belt driven generators operated from a jack-shaft, which is driven by four vertical turbines. The alternators are of 300 KW. each and deliver 3-phase current at 500 volts, which is stepped up to 22,000 volts for transmission.

POWER HOUSE, CANYON CITY, COLORADO.

The Mount Whitney Power Company in Tulare

THE FLUME OF THE MT. WHITNEY POWER PLANT.

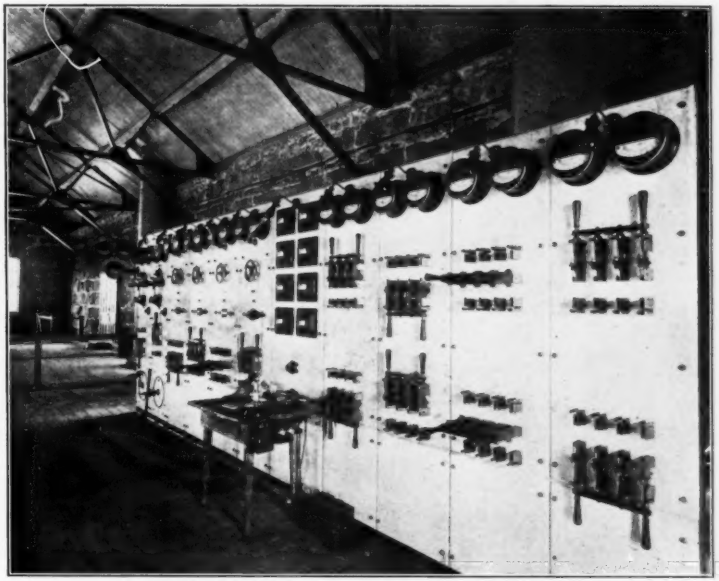
Showing the manner in which the water is carried along the mountain side to the head of the pipe line.

County, California, is notable as making use of the highest head of water utilized in any plant in this country or, perhaps, in the world. Water is taken from the Kaweah River by a granite dam, which can take the entire flow from the stream if necessary. The water is then conducted by a flume, provided with sand-boxes and settling basins, to a pipe line 3,300 feet in length. The latter has a total fall of 1,325 feet, and varies in diameter from 24 inches at the upper end to 19 inches near the water wheels. It is firmly anchored to the rocks and is provided with six air valves. The regulation of the wheels is accomplished by the use of deflecting hoods. There are three generating units consisting of 60 inch Pelton wheels of 700 HP. each, direct connected to as many Westinghouse generators of 450 KW. capacity. The latter run at a speed of 515 revolutions per minute and generate three-phase currents at 440 volts and 60 cycles. A cast steel fly wheel weighing 4,000 pounds is mounted on one end of the dynamo shaft, and the water wheel, which is carried by the other end of the same shaft, weighs 2,000 pounds. The voltage is raised from 440 to 17,300 volts in three oil-

THE PIPE LINE OF THE MT. WHITNEY POWER CO., CALIFORNIA.
This is a view looking down from the penstock along the pipe line to the power house.

insulated, self-cooling transformers of 500 KW. capacity each, with one spare. The transformers can be arranged in star connection to give 34,600 volts.

There are sub-stations at Visalia, Tulare, Porterville, Exeter and Lindsay, where the distribution is at 2,000 volts. A novel feature of the power distribution in this plant is the fact that interrupters are used on the lighting circuits. Current for lighting is sold to the consumer at flat rates and the interrupter causes the light to flicker when

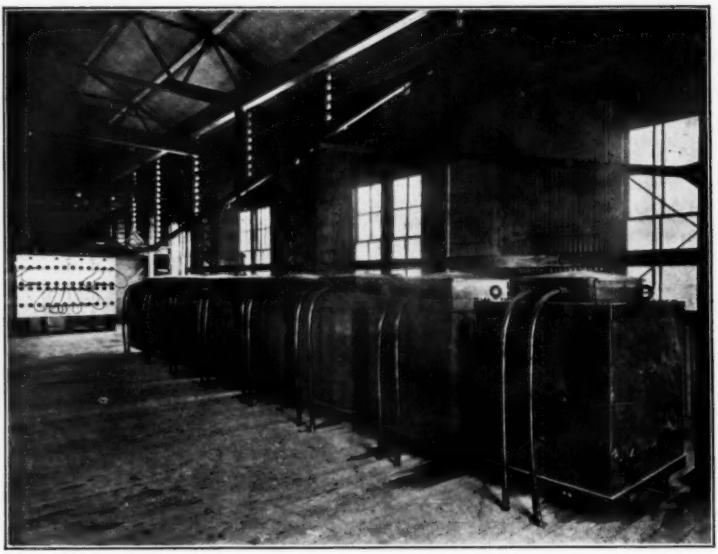


THE ALTERNATING-CURRENT SWITCHBOARD, HELENA, MONTANA.

he has turned on more lamps than are covered by his contract. A large amount of power from this plant is used in irrigation work.

The Keswick Electric Power Company, of Shasta County, Cal., has recently constructed a power house containing three 750 KW. Westinghouse three-phase alternators, direct connected to impact water wheels. The current from these machines is raised to 20,000 volts for transmission to an ore smelting plant at Keswick and to Iron Mountain.

The Missouri River Power Company, of Helena, Montana, is now building a 70 mile, 50,000 volt line from their power house at Cañon Ferry to Butte, Montana. They are at present supplying power for electric railways and lighting at Helena over a 12,000 volt line. This company has constructed a dam 40 feet high and 500 feet long across the Missouri River, forming a lake 1½ mile wide and six miles in length, and making available a head of 32 feet. They have now in operation four 1,200 HP., 60 cycle Westinghouse generators direct connected to turbines. Six more units are being put in and the complete plant will have a capacity of 12,000 HP. The 50,000 volt transmission will be over two pole lines. The poles are spaced 50 to 100 feet apart and carry three wires arranged in a 78 inch equilateral



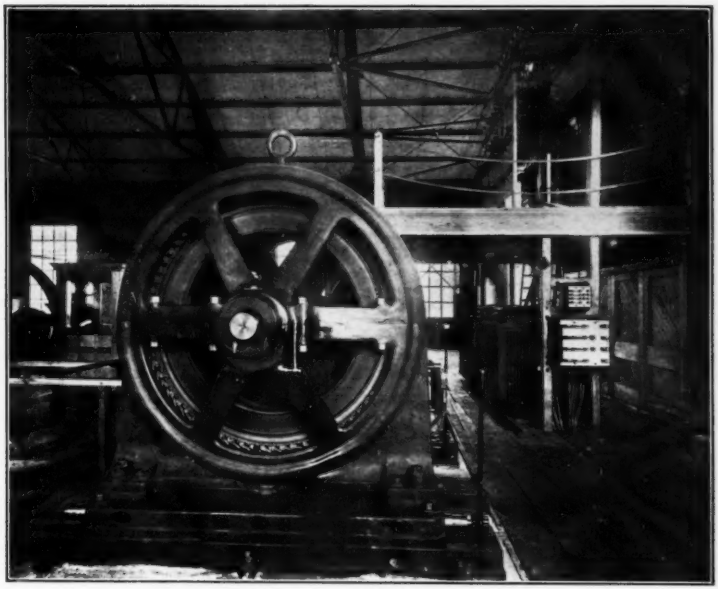
HIGH POTENTIAL TRANSFORMERS, HELENA, MONTANA..

Forming a part of the system in which a current of 50,000 volts is transformed to 2,200 volts. Missouri River Power Co.

triangle. At Butte the voltage will be reduced to 2,200 volts by six 950 KW., oil-insulated, water-cooled transformers.

The plant at Niagara transmitting to Buffalo is so well known that it is unnecessary to describe it here. It is pertinent to our present subject, however, to draw attention to the fact that the voltage at this plant has recently been increased from 11,000 to 22,000 volts, making it possible to transmit four times the energy over the same lines. Although this was intended when the plant was first installed it was thought best to gain experience with the lower voltage before adopting the higher for every day operation, the more so since the capacity of the lines was amply sufficient to transmit at the lower voltage all the power that could then be disposed of in Buffalo. However, the market for Niagara power has grown very rapidly, demanding the erection of a third transmission line and the above increase in voltage.

One of the most important uses of high-tension current at the present time is in suburban and interurban electric railway work. A notable example is furnished by the Union Traction Company, of Indiana, which operates a system of electric railways, including 153

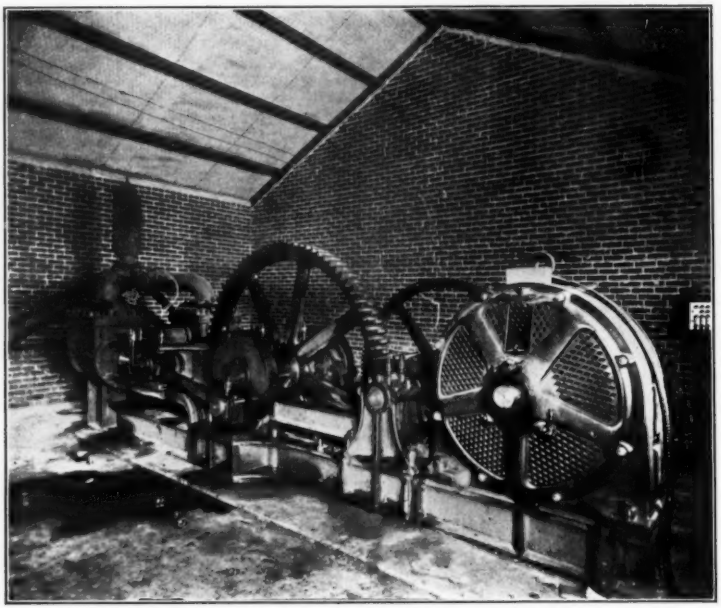


INDUCTION MOTOR, TRANSFORMERS AND HIGH POTENTIAL SWITCHBOARD, HELENA, MONTANA.

miles of track and serving 300,000 people, from one central power plant. This power plant is located at Anderson and distributes three-phase alternating current at 14,000 volts to eight sub-stations located along the railway lines running to Indianapolis, Marion and Muncie. These sub-stations are provided with transformers, rotary converters and storage batteries for furnishing direct current to the trolley lines. In addition there is a portable sub-station mounted upon a car which may be taken to any point to help out a local sub-station where the load is temporarily heavy.

Some interesting data have been obtained by the Union Traction Company, showing the cost of power at the bus-bars. In July, 1901, this amounted to $3,673.33 for 953,000 KW. hours, or $.00384 per KW.-hour. The road has been very successful and a number of extensions are contemplated.

It may be well to draw attention here to one or two general characteristics of these plants which we have omitted to mention. It will be noticed that in all cases a comparatively low number of alternations has been adopted. The reasons for this are that with a low frequency



INDUCTION MOTOR DRIVING PUMP, HELENA, MONT.

the self-induction and capacity effects of the line are correspondingly reduced; also, a low frequency is more suitable for the operation of motors and rotary converters. However, it should be remembered when designing a plant of this sort that the advantages of one frequency over another are only relative and that a small change in frequency one way or the other makes little difference; therefore, the engineer will do well to select a standard frequency, such as 25 or 60 cycles per second, in order that he may make use of the standard apparatus in the market. It will usually not be found advisable to go above 60 cycles, since that is high enough for most purposes and permits of the use of alternating-current arc-lamps. On the other hand, a frequency lower than 25 is unsuitable, since that is about the lowest at which incandescent lamps can be used without flickering.

Another characteristic of very high tension generating stations is that the current is generated at a comparatively low voltage, which is raised by the use of transformers. This is adopted in preference to generating a very high voltage directly, since high voltage generators are more costly to build than low voltage generators, are more vulner-

able to lightning discharges, being directly connected to the line, and are much more dangerous to the station attendants. While it is perhaps sometimes advisable to build generators to operate at 6,000 volts, it will usually be found more economical and satisfactory to obtain the higher voltages by the use of step-up transformers.

In conclusion, we will point out the principal improvements to which is due the present perfection of high voltage practice. While no new fundamental facts have been discovered in this field in the last ten years, most of the practical and substantial advances have been made during that time. There has been a great gain in the knowledge of the general conditions to be met, together with perfection in the details of the apparatus. Perhaps the most important of the latter are improvements in insulators, better transformer design and insulation, the perfection of adequate and reliable apparatus for protection from lightning and superior generator design. Among other developments, which have contributed to the success in this field are the perfection of the induction motor, and the introduction of the rotary converter for transforming alternating to direct currents.

It is to be expected that, with the present low rates of interest and the knowledge which has now been gained in this line of work, there will be a great and wide-spread development in this branch of engineering. There are doubtless hundreds of places everywhere more or less similar to those enumerated above where high-tension electric transmission plants would be found most profitable and secure investments. As knowledge of the availability of this new agent in modern industry becomes more widely spread among capitalists and manufacturers, we shall witness the installation of transmission plants in many places where cheap water power is available.

THE POSSIBILITIES OF A NEW TRADES UNIONISM.

By Percy Longmuir.

There are always two sides to a question, and the truth is often found by the study of both. Trades Unions have their advocates and their opponents; Mr. Longmuir gives us his idea as to how both parties may find unity and harmony in a newer Trades Unionism, beneficial alike to employers and employed.—The Editors.

THE series of articles which recently appeared in the *Times* on the British Industrial Crisis have aroused much attention and have led to a fair amount of discussion. Accusations as to deliberate restriction of output, the universal adoption of the "ca' canny" policy, and hostility to labour-saving devices, have been leveled with more or less intensity against the unions. We have a series of word pictures graphically drawn of men eager and anxious to do a full day's work but restrained from so doing by the union officials. There may be truth in these statements, but it is well to remember also a further fact of daily experience, and that is that any average man, unionist or otherwise, no matter what his calling, needs a strong incentive in order to yield anything like maximum output, and the slightest relaxation of that incentive has a marked effect on the turn-out. This is of course a mere truism, and in accordance with it we have the fact that any body of men engaged on work in which they have little interest and no feeling of responsibility, will shirk whatever they can, in short, adopt the "go easy" policy.

This spirit is not by any means confined to the ranks of trades unionists; even non-unionists take advantage of a foreman's absence. In passing it may be well to mention the fact that amongst non-unionists comparatively few are so from principle, the greater portion are so owing to the fact of their subscription having "run out" and as a consequence are suffering exclusion from the society. A natural result of this is that a large proportion of ne'er-do-wells, inefficient, topers, and the like swell the ranks of unorganized skilled labour. On the other hand, those non-unionists who are so from conviction form in the majority of cases a set of respectable intelligent workers, and in any consideration of non-unionists as a whole, it is well to bear in mind these two broad divisions.

The necessity of a motive or incentive for work has been mentioned and is quite as necessary in the case of an industrial worker as one whose work may be of a higher character. The tireless energy for which the British and American peoples are so justly famed can be exhibited to advantage only when those peoples realise their responsibility, or in other words when they realize the necessity for that energy being expended in any particular direction. Thus in certain times of National emergency, examples of which we have had of late both in the States and in Britain, a feeling of responsibility and an individual desire to share it has swept from end to end of the land.

"Then none was for a party,
Then all were for the State,
Then the great man helped the poor
And the poor man loved the great."

At these times of crisis the necessity for individual action is recognised and acted on collectively, and though such times may be of rare occurrence they form striking and noteworthy examples as to the capacity of a nation for simultaneous action.

The question naturally arises as to why this feeling of responsibility and the recognition of the need of individual action, of which we have occasional glimpses, can not be transferred from the national to the industrial arena, and immediately the answer suggests itself—"lack of motive." The apathy of the average worker to all progression is owing to his being unable to see the necessity for any advance, and his indifference to foreign competition is owing to the fact that the greater portion of the workers regard such competition as non-existent, or, to use a popular term, they regard it as a "bogey." Indolence never yet characterised a genuine British worker, and his present attitude of indifference and apathy towards advancing methods is the result of his environment rather than a deliberately assumed one of hostility. Some of these root causes have been already examined, and it does not require a very wide stretch of imagination to trace a relationship between this attitude of indifference and the general environment of the people adopting such attitude. If therefore this characteristic energy is to be maintained. it is evident that it must be fed and nourished in a congenial nursery and must be supplied with a motive warranting its full expenditure.

Modern industrial conditions, in which the personal element between employer and employee is necessarily absent, do not supply this motive; personal sympathy is missing and the relationship is

simply one of work and pay. Therefore personal interest in the work on the part of the worker vanishes, and it becomes more or less monotonous drudgery. The two chief things looked for are the closing-down bell at night and the pay days. There is little interest manifested during the working portion of the day, and in many cases even less during leisure time, and it is this lack of vital interest that is the deadly thing of all industrial lives; herein lies the canker that is eating out the heart and sapping all initiative and enterprise. Fill these lives with interest, give them something to work for apart from pay day, and a new set of beings is created. The workers must have an interest and a stake in the work they produce; let them know something of its nature, of its quality, and of the conditions the completed work has to meet in actual practice. Not for one moment is it implied that they should be consulted as to method or conduct of work, for any given ship has only accommodation for one captain on any given voyage; but the crew of that ship know before commencing their voyage whether they be bound for Arctic or tropical seas, and make their personal preparations accordingly. So, too, let our industrial crews have an idea of their destination, and give them the chance of making preparation to carry themselves creditably through.

There are many associations at work whose object is to supply interest and give a motive to life generally. Such efforts, though incalculably good on the whole, fail to supply interest in the sense required by the workers. Any institution organised, managed, and supported by themselves is bound, by the very nature of the case, to succeed in far greater measure than any society primarily intended to benefit the workers by external means. As evidence of this there are the trades unions; and organisation amongst the workers in this direction has yielded vast results. This associated energy has been chiefly devoted to questions of wages and hours of labour.

Although these matters are very essential from a worker's point of view, there are nevertheless other matters of equal moment which might be profitably included in the scope of an association professedly formed to guard the real interests of the worker. What constitutes the real interest of the workers is naturally difficult to indicate, but any scheme should keep an eye on likely future requirements—in other words, the condition of the children, who in time to come will swell the ranks of industry, should be guarded equally with that of present-day workers. The unions are certainly well within their legitimate sphere in maintaining the living-wage doctrine; where

they depart from that sphere is in the method of demanding it, in arbitrarily determining the amount of work to be done for it, and not only this, but also the manner in which the work shall be done. That paradox of high wages and low labour-cost is not understood as it should be in Britain. If the unions interfere as to methods of work they cripple present industry and at the same time ruin future industry, so taking away the bread from our own children. A union out of its sphere is a very big fish in shallow water, and when restrictions are placed on industry, they are so placed in most cases with comparatively little knowledge and less foresight. Some of this misapplied energy devoted to matters of more immediate concern to the workers would be productive of far greater good. The immense power wielded by a modern trade union is very evident. Why can not some share of this large force be directed to the workers' real benefit, in the shape of widening his interest and broadening his outlook?

Any scheme of this kind could be reduced to two essential features, namely, those of education and recreation. The education would not for one moment include anything of a routine or technical character; its chief aim would be to awaken and sustain interest pertaining to industrial lives. By giving reign to imagination we can suppose each trade union to be a kind of County Council, devising yearly courses of popular lectures, given preferably by members and followed by discussion, the feature of this course being variety of subject amply illustrated and each one treated in such a fashion as to be of direct interest to the hearers, whilst the advantage of discussion as an educative factor are apparent. Short courses of a more detailed character might be adopted to meet particular requirements, and these given by a specialist in the subject, still keeping to general rather than minute issues. The multitude of subjects which suggest themselves under this head make it impossible to give really representative ones, but any branch of economics so treated would be of immense benefit. A large field would lie in the direction of comparisons of this and other countries, particularly those countries which are our chief competitors. These comparisons would naturally branch out into the form of commercial and industrial contrasts and include examination of natural advantages. A few statistics, popularly treated by utilising the aid of suitable models and illustrative diagrams, could in a few and short lectures be made to yield a mine of information which would be of material assistance in aiding the formation of sound judgment. Scientific topics could follow, but general ones must necessarily take the first place owing to the fact that the immediate

necessity lies in giving a grounding for the better estimation of cause and effect by industrial minds. The chief aim of the work taken up should be to place the worker, who has not had the advantage of early training and who has been cramped by narrowing circumstances, in a position in which he can form sounder judgments on any matter relative to his own conditions.

Such effort, so initiated by any union possessing "go" and aided by a judicious use of its disciplinary powers, would eventually crystallise into several sections of sufficient variety to meet individual or natural inclinations. One can readily imagine these ideals fructifying into sections devoted to a discussion of trade difficulties, to studies of comparative methods of work, and to discussions as to methods for maintaining the best output consistent with quality and low cost of production. The more energetic minds would naturally associate in a section devoted to new methods, to the encouragement of original ideas and the development of invention, one result of which would be the formation of a mutual protective section to assist members in obtaining patents and a just recognition of them.

The idea of a union discussing trade matters and new methods with an idea of familiarising members with them, and so paving the way for adoption in works practice, may seem visionary; but nevertheless there is no reason why such discussions should not be taken up by the men most immediately concerned. The professions have it; why not the industries? The necessity for full discussion of appropriate topics is equally as important in the latter as in the former case.

On the recreative side, this scheme would endeavour to fill with healthy vitalising interest time which, when pockets are empty, is often spent in a very aimless fashion. When pockets are not empty it is unfortunately, in many cases, spent in a worse than aimless manner.

No scheme of this nature would be put into operation without the exercise of much diligent caution and each individual member of a society would necessarily have to subject himself to more or less discipline. That this preliminary discipline could be attained there is not the slightest doubt, and if needful the end could be achieved by the collective union exercising but a small part of the power now expended on objects not always to the workers' real advantage.

The necessity of an incentive or spur to work has been already referred to and in the case of industrial workers what better incentive can they have than their own consciences—or rather, their own awakened intelligence? This arousal of dormant faculties, this reawakening to the responsibility of industry, to the keenness of other

competitive nations, achieved through the aid of the workers' present organizations, would be of an extremely beneficial character to the industry of to-day and invaluable to industry of the future.

Such a training would in some slight measure patch up early lack of education; it would give an interest, a wider vision of life, and by aiding the individual to see a little further than the immediate present, assist in the formation of a juster estimate of actual life and produce a finer balance of industrial minds. Self help—not to quote Doctor Smiles—is undoubtedly the best; and such a scheme of self help as herein outlined would eventually overcome all opposition, trending to produce a spirit of reliance, a fair recognition of personal rights, and with it a due acknowledgment of the rights of others.

The effect of this spirit, judged collectively, would be found in wiser policies dominating the unions, a wider recognition of the necessities of industry, and whilst the present interests of the worker were guarded, a vigilant eye would ever be maintained as to his future requirements.

At present in far too many cases the gulf between capital and labour is regarded by the units comprising the latter half of the partnership as unbridgable—a sort of yawning chasm across which no connecting link can be thrown. This attitude may or may not be due to the capitalists themselves; but the fact remains that the majority of units comprising labour regard the units representing capital as natural enemies. In many cases when the capitalist does make an advance it is regarded by the recipients with suspicion if not absolute distrust. It is the same with new methods of organisation or management which do not appeal directly to the man's understanding, as for instance the "premium system;" they are regarded with suspicion or as a means of taking undue advantage. It has been shown that this attitude of opposition to capital or progress is not deliberately assumed, but is rather the result of crippling environment. With a wider outlook on the workers' part, this hostile attitude will gradually recede and ever increasing friendly relations be established. Capital and labour must be in amicable agreement and upon the strength and cordiality of this partnership will our successs in competitive industry depend. That there should be foreign competition is only consistent with the development of other countries, but if the two halves of our industrial partnership are in unison and hearty co-operation, competition then becomes but an incentive to fresh effort. This co-operation is not only possible, but feasible, once the workers see the necessity for it; and that in turn only

awaits arousal of their feeling of responsibility to themselves individually and to their industry as a whole.

What possibilities do not these thoughts open out! One direct issue is the formation of arbitration or conciliation boards equally composed of the representatives of "men" and "masters," each party having a full sense of responsibility and a just recognition of industrial necessities present and future. All differences rationally adjusted, fair and free discussion on either side, clearing away difficult points—opening the way for equitable agreement and adjustment. The strike or lockout then becomes buried in the archives of a mistaken past and though valuable as object lessons, are regarded with amazement by the disciples of the newer and awakened unionism. Evolution assisted by this combination of capital and labour, each based on a respect and knowledge of the other's requirements, moves steadily forward. Industrial and with it national progress is assured, the two essential factors moving onward in harmony.

Very briefly, then, this hypothetical attitude of the newer unionism, in addition to guarding the member's material wants as defined by a wages basis, is to take a certain moral charge and assist him to a better understanding of matters vital to his well-being—this endeavour being directed to raise the average level rather than that of the special (a genius can always take care of himself) resulting in an effectual guardianship of the workers' real interest and particularly that of the children who are to follow.

The practice of that which is ethically best we have defined in the words of Huxley:—"In the place of ruthless self assertion it demands self restrain; in the place of thrusting aside or treading down all competition, it requires that the individual shall not merely respect, but shall help his fellows; its influence is directed not so much to the survival of the fittest as to the fitting of as many as possible to survive."

Should any units of this mass show by special talent, aptitude, or inclination, a fitness to enter the lower branches of skilled industry and so work upwards, then give them every chance to do so, and not as is now the case, close every avenue of approach save one and crush every spark of ambition in men who may unfortunately have had no early chances.

And in the same spirit let the capitalist apply these words of Huxley and see that each of his workers worthy of the name receives a wage sufficient to enable him at least to maintain self and family in a state of physical efficiency or fitness.

EDITORIAL COMMENT

Regular readers of THE ENGINEERING MAGAZINE will recall the series of notable papers which appeared in these pages during the great strike in the British engineering industries in 1897-'98. That conflict was a very fierce one, and for many months the tide of public sympathy seemed to be with the workmen. But at length the Federation of Employers succeeded in convincing the newspaper editors and the public at large that it was not solely a question of granting an eight-hour day, or an advance in wages, but beyond that the Union insisted upon regulations which were both impracticable and unreasonable. The real issues in the contest were thus concisely stated by Sir Hiram Maxim, writing in these pages in November, 1897. Said he:

"The unionist, as a rule, is not a thinking man. It appears to his clouded intellect that there is a certain amount of work to be done, anyway, and that this quantity is fixed. Consequently, he looks upon work as something that ought to be nursed and made to go as far as possible. It appears to him that the more he gets per hour and the greater number of hours he can be employed upon a job, the greater the yield to his society. It never occurs to him for a moment that, if this were carried to extremes in either direction, the whole thing would be changed. For instance, if the cost of mechanical work should be increased twenty-five per cent. in England, the greater part of it would be driven into foreign countries; whereas, if it could be produced in England for twenty-five per cent. less than in other countries, there would be more than enough work for everyone who could be employed in England.

"Anything which serves to curtail or limit the output is not only detrimental to the country, but to the workman himself; and any society which encourages its members to nurse his job and make it last—that is, to dawdle, and to do it very slowly—not only does much to discourage the development of skillful mechanics, but also does great damage to the trade of his country."

It was the obvious truth embodied in this last paragraph which won a complete victory for the employers,—which defeated the workmen at every point. The very moment people were brought to see that the unions were driving trade out of the country by insisting upon regulations which were unreasonable, that moment public sympathy turned squarely to the employers.

It was a costly campaign, but in educational experience it was priceless in value, for it taught British employers that the true and sure way to gain public sympathy and effectively regulate the unions is to employ the cold logic of facts—to reason with the men rather than attempting to tyrannize over them; and, especially, to make public in temperate language the known conditions of world-wide competition.

* * *

Precisely similar methods were em ployed a year ago by American manufacturers, and again with notable success. Confronted by unreasonable and impracticable demands on the part of the union leaders, the employers united in self-defense, made public all the facts concerning each point at issue, and at once common sense and public sympathy were lined-up in defense of two essential principles of industrial liberty, namely: (1) that the proprietor must be free to manage his own business—precisely as the employee must be free to leave at will; and (2) that trade-union regulations which limit a workman's output or prohibit the use of improved methods and machinery, are indefensible and unjust, because they increase the cost of manufacture and drive work out of the country.

These valuable lessons so lately learned have put us well along the

highway which leads to industrial peace. For obviously trades union leaders can not long withstand the cold logic of facts and known experience; and obviously, too, both the facts and the proper methods for using them are now within easy reach through the admirable organizations of employers which have been formed.

But if we are in a fair way to escape from the fallacy of "restricted production" through trades union regulations, we are still held firmly in the grip of that twin fallacy and folly—a belief in "over-production."

Over-production is assumed as a matter of course—because it is always talked about, especially in the newspapers; and everybody sees that manufacturers in all lines are constantly forming pools, combinations, and "trusts," the purpose of which is to restrict production and hold-up prices.

But the truth is that over-production is an absurdity. It never has occurred —never can occur! And the mere fact that so many manufacturers believe in the false theory, and act upon that belief, is precisely what makes the fallacy so mischievous and so damaging. Mr. G. H. Hull made all this perfectly clear in his admirable paper contributed to our last number,* and we again refer to it editorially because of the importance of a correct understanding of the subject. That article is, in fact, one which should be carefully read by every thinking man who is concerned with the production of raw materials and the great staples of manufacturing industry; and as evidence of the force of Mr. Hull's argument we submit the following brief extract :

> Only a few years ago there were seasons when the receipts of fruit in all large cities were sometimes so great within a few days, that the fruit scarcely brought the amount of the freight. Very often large quantities went to decay for lack of demand. This in turn discouraged shipments, and then would succeed a season of great scarcity. It took experience and many years of loss to rectify this condition, but finally it was accomplished by the establishment of fruit exchanges and cold-storage warehouses, where fruits can be preserved in a perfect condition for months. The result is that prices of all such products are now more stable, the public is more regularly supplied, at all seasons, consumption has been enormously increased, and the profits of both producers and dealers are more uniform and remunerative. It was *Temporary surplus production* of fruit, before it was brought under intelligent control, which caused irregularity in the supply.
>
> In our ignorance we called it over-production.
>
> It was not over-production.
>
> It was *temporary surplus production.*
>
> By creating the modern systems of transportation, and by inaugurating the present system of cold storage, two long strides have been taken. Neither of these advances would have been possible but for the existence of one of nature's greatest gifts to man, *temporary surplus production.* Yet another long stride forward will be taken when the producers of staple commodities like coal, iron, steel, tin, copper, lead, and rubber, clearly understand that THE PRESENT SYSTEMS OF STORING THESE PRODUCTS ARE WHOLLY INADEQUATE.
>
> Is it not good business to gather surplus products when they are plenty and cheap and hold them until they are scarce and high? Have any ten years passed in the recollection of men now living, in which the people of the foremost manufacturing nations have not suffered for the want of an adequate supply of some of the great staples—coal, iron, steel, tin, copper, rubber—which might have been stored up in times of dull trade? Has any one ever heard of useful manufactured products being destroyed for want of a market? Have they not all been consumed in time? Is not this proof that each one of the over-production claims put forth during the last two and a half centuries has been rank nonsense?
>
> As man masters the art of dealing intelligently with the temporary surplus production of each article, we hear no more of over-production in connection with that article.

And the deduction from this reasoning gives us Mr. Carnegie's simple and notably successful rule of manufacturing upon the largest possible scale, and selling at a price so low that it is certain to capture orders; in other words, stimulate demand through low prices !

* The Mischievous Fallacy of Overproduction, THE ENGINEERING MAGAZINE, March, 1902.

REVIEW OF THE BRITISH PRESS

Engineers in the British Navy.

WE reviewed, a few months ago, in these columns, that portion of the report of the Engineer-in-Chief of the United States Navy which referred to the non-success of the personnel bill and to the importance of taking decisive action as to the proper manning of the engineering department. The United States Navy is not the only one which is defective, to use a mild term, in this respect. In a recent paper, presented before the North East Coast Institution of Engineers and Shipbuilders by Mr. D. B. Morison, we have a report on the memorandum submitted to the First Lord of the Admiralty with reference to the present unsatisfactory condition of the engineer branch of H. M. Navy, and this, together with a previous paper upon the same subject by Mr. Morison forms interesting if not very satisfactory reading.

The present condition of the engineer branch of the navy is certainly most unsatisfactory, not only to the engineers themselves, but to all who have the welfare and even the safety of the empire at heart, both within the navy and without. This was clearly shown by the reception which was given by the "ruler of the king's navee" to an important deputation of members of Parliament and representatives of engineering institutions who attempted to present the facts of the situation to those who have the authority and power to correct the existing evils.

The whole state of the case may easily be laid before the general reader. The executive branch of the navy consists of the official descendants of the officers of the old days of Britain's naval glory, before the days of steamships, auxiliary machinery, electricity, water-tube boilers and other mechanical contrivances. These gentlemen, being of a conservative turn of mind, are unwilling to admit that there has been any real change or advance in the *matériel* of naval warfare, and regard the idea of the engineers, by whom these new fangled mechanical devices are handled, that they should have any executive authority, as utterly preposterous. Since the admiralty is equipped with executive officers only, no engineers being given place thereon, it has been found practically impossible to give the engineer branch any real command over the work which they alone are qualified to handle.

It sounds like a situation from a comic opera, and if it were not so serious it might become altogether laughable. It is far too serious, however, to excite any feelings but those of dire apprehension among those who are really qualified to judge. The widespread imperial position of Britain is too vulnerable, and the dependence of her people for existence upon sea-borne food stuffs is too great to render these questions anything but most important to every thinking citizen. Especially is it important that this subject should be agitated and discussed now, while there is time to train men for the work, to rid the service of incompetent or unsuitable men, to place the navy in fit condition to be what it should be, the mainstay of the existence of the British Empire.

Let every thinking Englishman recall the dark and gloomy forebodings with which every heart was filled during the reverses in the early days of the war in the Transvaal. Then let him think again and compare the state of the British army for that task with the present state of the British navy for a contest with any other first-class power. He can obtain the facts for this consideration fully and faithfully presented in Mr. Morison's paper, and he can find there also the apathy and indifference with which the danger call was received by those in high authority by whom in truth the danger should first have been perceived.

Far more important is the state of the navy personnel than was, or is, the condition of the army. The loss of the Trans-

vaal would indeed have been a disaster, but how incomparably greater would be the disasters following the successive breakdown of vessel after vessel in time of war, not with a minor South African State, but with a European power; breakdowns due not to the superiority or capacity of the enemy, but to the undermanning of ships, to the incompetency of those placed in unexpected charge of machinery, to the fatuous condition of unpreparedness, of jealousy, of discouragement existing to-day.

The engineers of Britain are second to none in the entire world. The development of the modern fighting machines upon which the existence of the empire depends, is due to the ability and genius of British engineers. The whole defense of the land could safely be placed in the hands of British engineers, controlling and operating British warships, but the control should not be delayed too long or it may be too late. It is only a question as to which nation will take the first step in the realisation of the transformation in naval warfare which is already upon us. We may be able to imagine in some small degree the indignation of the feudal knight who after a life of training for warfare according to the methods of his fathers found that the introduction of "villainous saltpetre" had made the veriest peasant his superior. The transformation in warfare wrought by the introduction of firearms is small, however, compared to that which is impending in the introduction of fighting by engineers and engineering methods alone. Conservatism will not serve in the warfare which is practically here already. It is the nation which keeps itself constantly in the forefront with the latest mechanisms, the most skilful engineers, the most modern workshops, the most complete and fully organized methods, which will sweep aside in its irresistible advance the whole flock of conservative martinets who are incapable of seeing or thinking except with the methods of a past which is none the less useless because it is but yesterday.

The Overcrowding of Cities.

A THOUGHTFUL paper upon the vital subject of municipal overcrowding was recently read before the Society of Arts by Mr. W. L. Madgen, and some of his suggestions are so eminently sensible that they may well be reviewed and emphasised.

Confining his remarks to London, Mr. Madgen well says that one of the first things to strike the visitor to the metropolis is the apparently hopeless entanglement and obstruction of traffic. The great city is so congested at certain localities and at certain hours that progress is only intermittently possible, and then with great waste of time, energy and temper.

It is apparent upon inspection of the problem that there are present two elements to be considered, one being the best method of providing for the requirements of the present and the immediate future, while the other is control of the growth which is progressing yearly at an accelerating rate. It is this second feature, the rate of growth, to which Mr. Madgen especially devotes himself, and with reason. It is to small benefit that improved methods of transit are furnished, more and cheaper houses built, increased water supply provided, if the influx in population continues to exceed the capacity of such improvements. The remedy therefore, may be found in the operation of prevention, at least partially.

Workmen, receiving but moderate wages, must live near their places of employment, and if those places of employment are in the metropolis, there the workmen must be crowded, often in unsanitary quarters, and rarely, if ever, with such comfort as might be obtained elsewhere. For many industries, however, London is by no means an ideal situation. The causes of its growth are two: its advantages as a seaport; and, the fact that it is the seat of government and the court residence. Neither of these facts need render it a desirable place for manufacturing purposes.

"It is fairly certain that no manufacturer about to commence business at the present day, would fix upon London as a suitable position. He would choose rather a district in which land was cheap, and in which he could obtain cheap power for his machinery and transport for his goods. He should not in future be limited to the colliery districts, or to the main lines of railway. Light railways, serving as feeders to the main lines, and the supply of electrical energy over large areas from main power stations, could provide for both these requirements, giving the

manufacturer ample assurance that his works could be run cheaply, and that the raw material and manufactured products could be efficiently handled. By such means, electrical science is capable of opening up thousands of square miles in England for manufacturing purposes, the native population of which has been languishing under the chronic complaint of agricultural depression."

The remedy, then, for the overcrowding of the metropolis is to render it more desirable for manufacturing industries to establish themselves in smaller towns, scattered over the kingdom, and this can be done by providing cheap power and cheap and convenient transport. This transport would not only enable the merchandise to be handled to advantage, but would also make life sufficiently attractive, by providing access to neighboring cities, to overcome the desire of many to escape from the dullness of the small town by crowding to the metropolis. When, however, the engineer has planned a system of power generation and transmission, and a scheme for interurban transport, all perfectly feasible and successful from an engineering standpoint, he finds that obstacles wholly of a political nature prevent their execution. Boundaries, fixed ages ago, for the purpose of local administration, under conditions altogether different from those which now obtain, are permitted to interfere with the development of plans of the greatest public importance.

"When personal enterprise seeks to further the modern system of electric power distribution, or light railway construction, it widens its plans to include groups of towns, so that the population of the whole district gets the benefit of a comprehensive scheme, contrived in such a manner as to effect the utmost economy and utility. Yet such schemes, manifestly of national importance, which bear an intimate relation to this overcrowding question which we are discussing, almost invariably meet with bitter and strenuous opposition from the aldermen and councillors of the several towns, who demand that the large area which has attracted the attention of the advanced electrical engineer shall be parcelled out into a number of small local monopolies worked on antiquated lines. Each town must have its own toy generating station, and its own little train-line shuttling from one street corner to another, and an enterprise which has projected a network of light railways connecting, perhaps, half a score of towns, and a comprehensive scheme of cheap power supply, is obstructed on the ground that the boundaries, which were fixed simply with reference to the maintenance of order and the control of public health, are equally well fitted for traction and power schemes.

If these restriction can be removed, the question of the overcrowding of the great cities may be solved, not by making them more attractive to newcomers by providing increased facilities, but by rendering a great number of small towns more suitable for manufactures and trade, thus drawing away from the great cities much of the population with which they are now congested.

Mr. Madgen discusses this idea at length, and formulates the conditions under which, in his opinion, the task of adapting the small town to the requirements of industrial sites, and consequent increase of population. The whole question appears to be the apparently simple one of permitting the engineer to do his rightful share of work in benefitting the community and by relieving him of the shackles of obsolete limitations.

The Development of the Gas Engine.

WHEN Mr. Dugald Clerk has anything to say about the gas engine, there is certain to be interested attention; since his large experience, especially with the early history of internal combustion motors, renders him especially well qualified to speak. For this reason his recent paper before the Institution of Engineers and Shipbuilders in Scotland, published in the *Transactions* of the Institution demands attention and comment.

Before discussing the detailed construction and operation of the gas engine, Mr. Clerk describes very clearly the true nature of the explosion as it occurs in such engines, showing its difference from the explosion produced by gunpowder, cordite, or other solid explosives. In a gunpowder or cordite explosion a chemical change is effected, whereby a solid or semi-solid substance evolves large volumes of gases; that is, the solid substance, after chemical decomposition, produces gases which, when

cooled, are hundreds of times the volume of the original solid powder. In addition to this evolution of gas, great heat is produced by the chemical action, and so very high pressures are obtained. The substances as producing pressures within a gun are quite unsuitable for obtaining controllable motive power, and, although attempts have been made to actuate engines by gunpowder and gun cotton, yet all such attempts have been failures. A gaseous explosion is a much more controllable phenomenon than a powder explosion. In gaseous explosions the action is much simpler. There is no change of state during the reaction from solid to gas; on the contrary, in all ordinary gaseous explosions the volume of the gases formed by combustion, reduced to standard temperature and pressure, is less than their original volume before combustion. In the gaseous explosion the increase of pressure is due wholly to the increase of temperature of the gases entering into the chemical action.

In order to obtain experimental data concerning the explosions of mixtures of air and gas in closed cylinders Mr. Clerk used an apparatus consisting essentially of a cylindrical vessel, upon which was placed an indicator, differing from a steam engine indicator in that the reciprocating drum was replaced by a revolving one, the rate of revolution being regulated by a revolving fan, connected to the gear train and weight by which the rotation was produced. By starting the drum in revolution, and causing an explosion to take place in the cylinder, a diagram was produced showing the pressure at every instant of time for the especial gas mixture under test. A study of numerous diagrams produced by this apparatus showed in no case higher pressures than about 100 pounds per square inch. The nature of the curves also showed that a gaseous explosion is a strictly controllable phenomenon, quite unlike the explosion of gunpowder or gun cotton.

After describing the early, non-compression engines, Mr. Clerk refers to the statement by Mr. Beau de Rochas, in 1862, of the true operative cycle of the modern gas engine, followed by its practical application at the hands of Dr. N. A. Otto. As an indication of the success of this principle it is stated that there is not less than half a million horse power at work in Great Britain and probably 300,000 horse power on the Continent. Including American engines, and the large engines recently built for use with furnace gas, the gas power of the world at present is at least a million horse power.

The earlier engines employed the flame ignition, using a slide valve with opening for the communication of the flame with the interior of the cylinder, together with a relighting flame, the whole being only partially satisfactory. The degree of compression was also moderate, usually about 30 pounds above atmospheric pressure.

It was soon realized that higher degrees of compression would conduce to greater economy, but it was necessary to devise some more satisfactory method of ignition before the pressure of compression could be increased. This requirement was met in two ways, first by the introduction of the "hot tube" ignition in England by Watson, and in Germany by Daimler, and then by a return to the use of the electric spark, which latter had been employed in the old non-compression engines of Hugon and of Lenoir. With these modifications came a diminution of the relative volume of the compression space and a consequent increase of the compression, engines of the Otto type now using a compression of 90 to 120 pounds per square inch above the atmosphere. The proportions of the valves and ports have also been modified so as to minimize the throttling of the charge during the inlet period and the back pressure of the exhaust gases during the discharge. These various improvements have raised the thermal efficiency from 16 per cent. in 1882 to 25 per cent. in 1894, and some recent tests of large engines have shown an efficiency of 30 per cent.

When liquid hydrocarbons are used instead of gas, the principal modifications required are those involved in the conversion of the fuel from the liquid to the gaseous state. In the earlier forms of oil engines, and in those used in motor cars, very light inflammable oils of the gasoline or petrol kind are consumed. Here the problem of vapourizing the oil is comparatively simple. It is only necessary to draw air over a surface saturated with one of these light oils, or throw a jet of light oil into an air

current, to produce a mixture of inflammable vapour and air which, when taken into the cylinder, readily supplies the place of coal gas, and gives explosions under compression closely resembling those obtained with coal gas.

Light petrol is too dangerous for use in large quantities within buildings in towns, or even in the country, and, accordingly, heavy oil engines have been produced, and are sold in considerable numbers. Heavy oils are those which have a flashing point above the Parliamentary standard of 73 degrees Fah. Such engines may be divided into three distinct classes:—

(1.) Engines in which the oil is subjected to a spraying operation before vapourization;

(2.) Engines in which the oil is injected into the cylinder, and vapourized within the cylinder; and

(3.) Engines in which the oil is vapourized in a device external to the cylinder, and introduced into the cylinder, in a state of vapour.

Mr. Clerk is a full believer in the future of the internal combustion engine, including both gas and oil engines.

So far as economy of heat is concerned, both have considerably surpassed the best steam engines; but much remains to be done before they equal the steam engine in frequency of impulses, lightness of machinery, and absolute steadiness of governing; in power of control, for instance, where reversal is required. As yet, the application of gas and oil to any but fixed engines, has been very limited; but ultimately, I have no doubt, gas and oil engines will be used with great advantage for propelling ships, and for driving locomotives.

Referring to the lines along which future developments may be expected, Mr. Clerk inclines to the belief that it will be in the direction of a combustion rather than an explosion motor. Says he:

"In 1887, I had an experimental combustion engine of my design running in Birmingham, giving about 7 H. P., at 150 revolutions, with great smoothness; and since that time I have continued experimenting in that line. Other inventors have also experimented in the combustion engine line, including Herr Diesel; and there is good hope for believing that in time a constant pressure gas engine will be produced which can be as easily handled for marine purposes as a steam engine. At present, of courase, there is no possibility of reversing or cutting off power impulse in the way done in steam engines. Apart, however, from the engine, further work requires to be done in connection with gas producers before marine gas engines become commercially feasible. Both in Germany and this country several inventors are at work upon gas producers intended to use ordinary steam coal, which would produce gas on board ship, without gas-holders, and supply the gas direct to marine or other engines. One great point is to get rid of the present gas-holder. Several inventors have made this attempt. Perhaps the first engine of this kind to be run in public was that of Mr. Benier; but recently I inspected at the little suburb of Heusy, near Verviers, a gas plant supplying two 80-horse Otto cycle engines, in which no gas-holder was employed.

"In my view the gas engine affords to the engineer and inventor an enormous field of work, likely to result in a very considerable revolution, certainly in land engine work as well as marine work. A gas engine with an efficient gas producer would easily give 1 I. H. P. on half-a-pound of coal per hour, as against 1¼ to 1½ lbs. for the best steam engine now in use; that is, power for marine propulsion could be obtained at less than half the present cost.

"Many engineers are now at work on the subject, and when the problem is further solved, it will aid much in meeting the fuel difficulty, which must face this country at a comparatively early date. My view is that the nineteenth century was the century of the steam engine; and that the twentieth century will be the century of the gas engine. Steam will ultimately be displaced almost entirely by gas engines."

The Uganda Railway.

A DESCRIPTION of the route and construction works of the Uganda railway was given in the July, 1901, issue of THE ENGINEERING MAGAZINE by Mr. F. W. Emett, and now we have the very interesting account of Commander B. Whitehouse, R. N. before the Society of Arts, describing a journey from Mombasa, on the Indian Ocean to the shores of the Victoria Nyanza

over the railway. A most interesting feature of the occasion of the reading of the paper was that the chair was occupied by Sir Henry M. Stanley, who, nearly thirty years ago traversed this region against all the obstacles which have now been permanently overcome.

Work was begun on the railway in December, 1895, and the first locomotive reached the shores of the lake in December, 1901, and in these six years the journey from the sea to the great lake has been cut down from a dangerous expedition of eight months' duration to a speedy and comfortable trip of two-and-a-half days.

The difficulties of the work can only be hinted at here. The route climbs to a height of 7,900 feet at mile 355 at the Kikuyu escarpment, then descends to 6,000 feet at lake Ementeita, again ascending to 8, 320 feet at mile 490 on the Mau ranges, descending to the lake at a level of 3,726 feet above the sea at mile 582 over a route for most of the last 100 miles that previous to September, 1898, no European had ever trodden.

"Never before has a railway been built under such extraordinary conditions or caused such radical changes in the country through which it has passed. Till other railways are constructed the whole of the trade of that part of Central Africa must come to it. The way the country has been opened up by it is very marked; rupees are in constant use where previously only beads, cloth, and wire were asked for. The journey from Mombasa to Port Florence, on the opening of the whole line, will take two and a half days, and another day can be allowed for the steamer journey of 143 miles to Mengo, the capital of Uganda—three-and-a-half days instead of about seventy by the old caravan route All the privations, delays, and trouble of the caravan road are things of the past, and travelers now pass through the country in a first-class sleeping carriage at a charge of three pence per mile, with rates for their goods that compare most favourably with some of the other railways in Africa. Cable messages can be sent from any station on the railway, and a telegraph line has been laid into Uganda from Port Florence."

In addition to the actual work necessary for the construction of the railway, the whole of the coast line of the British half of the Victoria Nyanza, with all the islands that are known to exist in it, has been surveyed, under the superintendence of the chief engineer of the railway; the early and incorrect information concerning the coast being thus reversed.

The result of all this work can now clearly be foreseen. The slave trade is practically abolished, the whole magnificent country, with its possibilities of rubber, tobacco, coffee, and other tropical products, is thrown open to the commerce of Europe and Asia, while the great lake may now be equipped with steamboats, and rendered a most important means of communication between all points on its shores.

The whole work shows once more the tremendous power which the engineer plays in the exploitation of the world. Savagery and barbarism recede before the advance of the locomotive, where the progress of military forces would be most stubbornly opposed. In the case of Africa there is little doubt that the land can be opened up far better by the construction of railways from various points on the coast into the interior than by one great longitudinal railway, such as has been discussed from the Cape to Cairo. Africa has the sea on either side, the best and readiest highway for communication and transport, no railway is needed for that service. It is the interior which should be penetrated by many railways, each reaching to its seaport and enabling the heart of the continent to be dark no longer, but brought into enlightening communication with the sea which connects all parts of the world with each other.

The Imperial Cable.

WITH the construction of the British Pacific cable, there is undertaken not only the largest piece of submarine cable work yet attempted, but there is also inaugurated a new departure in politics. These features are both emphatically brought out in an article upon the Imperial cable, in a recent issue of *The Engineer,* from which we make some abstracts.

The political idea lies in the fact that it involves cable communication across the Pacific, made for strategic as well as commercial purposes, and owned by the state, or rather states, concerned—that is to say,

Britain, Canada, New Zealand and Australia. Through the existing Atlantic cables landing on Canadian soil, such as those of the Anglo-American Telegraph Company and the Commercial Cable Company, it will connect the mother country with Canada, Fiji, and other South Sea islands, Australia, and New Zealand. All the stations will be under the British flag, and independent of any foreign control.

The original idea of Sir Sandford Fleming was to lay a cable by the northern, or great circle route by way of the Aleutian and Kurile Islands to Japan, this being not only the shortest route, but also the most feasible because of its subdivision into several short lengths. The great advantages of this route are well known, and have been fully set forth in the exhaustive paper of Mr. Harrington Emerson, in THE ENGINEERING MAGAZINE for November, 1899, but evidently this route does not comply with the requirement that all the stations should be under the British flag. The selected route, therefore, is from Vancouver to Fanning Island, Fiji, and Norfolk Island, with branches from there to Australia and New Zealand.

The great question concerning the cable is that of profit and loss. It is estimated that the cost for making and laying will be about £1,500,000, and that £150,000 a year will be required for maintenance and operation, as well as interest and a sinking fund for redemption after fifty years. The earning power of such a cable depends largely upon the speed at which it can be worked, and this again depends on the length and the section of the core. These questions are discussed at length in the paper, and while no definite dimensions are given, it was recommended by the committee that something between the suggestion of Lord Kelvin of 552 pounds of copper and 368 pounds of gutta percha per nautical mile, and the Anglo-American Company's cable of 650 pounds of copper and 400 pounds of gutta percha should be used. Such a cable would have a speed of about seven or eight paying words per minute, and it is expected that in a few years the business would become profitable, even at a reduced rate of 2s. a word.

Unusual secrecy is preserved regarding this National and Imperial cable, but it is understood that the Vancouver-Fanning section, the most novel and interesting from an engineering point of view, is very similar to the Anglo-American cable of 1894. Every drum of the core is submitted to a hydraulic pressure equal to that of the sea bottom, and severely tested with powerful alternating currents, to break down latent flaws or faults. The core is defended from the teredo by brass tape, and sheathed with steel wire of great strength. The southern sections are to be laid during the present year, and the whole is to be completed by the end of the year.

It is a question whether the advantages of an all-British cable are likely to be realised. The mere possession of the landing territory adds but little to the safety of the cable in time of war, and indeed it is stated that it "may be necessary to fortify the stations and patrol the line with fast police cruisers," so that the mere possession of the landings is admitted to be insufficient to protect and maintain communication.

As a matter of fact, a cable landing in the territory of several nations and owned jointly by several governments, appears to be less liable to interruption than one under a single ownership, and if this is admitted there is no good reason for abandoning the otherwise superior northern great-circle route. Government despatches can always maintain their secrecy by use of special codes, and no inconvenience is experienced in this respect on the existing Atlantic cables, while the greater speed and lower cost of the shorter lengths of the northern route appear to outweigh the sentimental points which have been advanced for the all-British line. It is quite certain that, should both be constructed, the cheaper route would be able to control the commercial business, so that the Imperial route would practically become a private government line, and would have to look to the government for its maintenance. Such a duplication of cables is not to be expected immediately, but if the precedent of the Atlantic is to be taken as a guide there will doubtless be more than one cable across the Pacific in the not distant future, and in such case the operation of competition can only be prevented by the institution of some form of monopoly.

Electric Shock.

At a recent meeting of the Institution of Electrical Engineers, three papers were read on the general topic of "Electric Shock," in which various aspects of the subject were discussed.

Major-General C. E. Webber's paper gave, first, a general account of the physiological action of electric shock, with the views of many experimenters, and then went on to review British legislation on protection against electrical accidents, and, particularly, "the events which led up to the inclusion of electrical generating and transforming stations in factory legislation."

Mr. A. P. Trotter occupied himself entirely with "Electric Shocks at Five Hundred Volts," the pressure which is most usual in electric traction, and which therefore has a special interest. He divided his subject into three parts: (1) The physiological and electrical conditions; (2) the dangers connected with trolley wires; (3) the dangers of third rails of electric railways.

"The physiological sensation does not depend directly on the actual current, but on the current density. With four or five square inches of contact between dry metal and bare skin, (for example, grasping a trolley wire), a steady continuous current of 1 or 2 milliampères is hardly perceptible, from 3 to 8 easily supportable, above 10 is painful and above 35 almost unendurable. More than about 14 milliampères of steady continuous current at the finger tip, making a poor contact of about one-sixth of a square inch, is unendurable, but 35 milliampères from boot to boot, nearly the whole of the soles of the feet being in contact, is much less painful.

"The dangers of electric shocks at 500 volts have been much misunderstood, greatly exaggerated and little investigated. The pressure of 500 volts has been deliberately chosen by electrical engineers because it is not dangerous under ordinary conditions."

The conclusions to be drawn from the many experiences cited by the author are that with *dry* shoes and clothes there is slight probability of receiving a dangerous shock from accidental contact with trolley wires or third rails carrying a current at a pressure of 500 volts, but with wet clothing and in wet weather there is danger of getting at least a very disagreeable shock, and in a few cases, prolonged contact with conductors at 500 volts has caused death.

Mr. F. B. Aspinall discusses a number of points, his questions and the gist of his conclusions being as follows: 1. Is every one equally susceptible to an electric shock? Not only are different people differently affected, but the same person under different conditions does not experience the same sensations.

2. Is a person suffering from disease more likely to be fatally injured by an electric shock than a person in good health? This will depend upon the disease.

3. Does the physiological condition one is in at the time a shock is received make any difference? A man when drunk is less likely to be fatally injured, and a person when asleep is peculiarly unsusceptible to shock so that condition appears to have a decided influence.

4. Does the path which the current takes through the body have any effect as regards the shock proving fatal? The path has a great effect, the left side being the more vulnerable.

5. Does the question of contact made, and whether burning takes place or not, have any effect upon a person's chance of being killed? The question of more or less good and large contact is the most important of all, and largely determines the result of a shock. When there is severe burning, there is less probability of a fatal termination.

6. Can a person receive a fatal shock without giving the "cry," and also can he speak after receiving a fatal shock? Yes, to both questions.

7. Is an alternating or a direct current shock more likely to prove fatal? The danger from shock is the same with both, but more burning takes place with direct current.

8. Cannot the doctors give us a more certain method of ascertaining whether a man is dead or not? The present methods are unsatisfactory.

9. Cannot something more be done to help those who receive a shock? Artificial respiration should always be induced, but first the body should be held for a few seconds head downwards at an angle of 45 degrees, thus flushing the brain and stimulating its action, which is the treatment used for collapse from chloroform.

Superheated Steam for Locomotives.

ALTHOUGH the advantages due to the use of superheated steam have been known for a long time, there has been little attempt to introduce superheaters in locomotive engines, probably because of the dislike to the addition of further complications. At the present time, however, when every attempt possible is being made to increase the capacity of locomotives without overstepping the limitations of the loading gauge, superheating for locomotives is being seriously considered.

In a paper presented recently before the Verein deutscher Ingenieure, and published in the *Zeitschrift* of the society, Herr Garbe discusses the Schmidt superheating device for locomotives, and shows how the economy in fuel, or the increased capacity for the same fuel consumption due to superheating may be obtained.

The Schmidt apparatus for superheating is ingenious, and readily understood. Instead of filling the barrel of the boiler below the water-line entirely with small tubes, there is placed in the lowermost portion a flue about 12 inches in diameter, running from the fire box straight through to the smoke box. In the smoke box is placed the superheater, this being composed of small bent tubes, forming a nest below, just where the hot gases from the above-mentioned flue are delivered, and curving up around both sides of the smoke box to the steam-pipe connections above. This portion of the smoke box is separated from the central part, into which the small tubes discharge their smoke and gases, but both portions discharge into the chimney above. Suitable dampers serve to control the amount of draft through the large flue, so that no heat is wasted, the amount passing through being regulated according to the temperature of the chimney gases.

By this construction it is possible to superheat the steam much higher than would be the case if only the waste gases were used, while at the same time no heat is lost, since the flue itself furnishes valuable steam generating surface in the boiler, and also a proper adjustment of the dampers prevents an excessively high temperature in the chimney. In order to obtain the best results the steam should be heated to at least 300° C., or, for pressures of 10 to 12 atmospheres, to a temperature of about 100° C. above that of saturated steam. Two important results are obtained by this degree of superheating: the steam is increased in volume about 25 per cent., and the wasteful drop in pressure at the point of admission into the cylinder is obviated, when the link motion is set so as to give the best point of cut-off.

It is unnecessary to rehearse here the often-repeated advantages of superheating, since it is now generally admitted to be the most effective remedy for the losses due to cylinder condensation. In stationary practice a fuel economy of 20 to 25 per cent. has been obtained by the use of superheated steam in properly designed engines, and if it is to be employed with success in locomotives, the experience obtained in stationary practice may be recalled to advantage. The cylinders should be proportionately larger for the same power development, and every precaution should be taken to avoid trouble from unequal expansion, due to the higher temperatures of working. In the engines described by Herr Garbe, piston valves are employed, and these may be all right, if suitable packing is used.

The American design of casting the cylinder in one piece with the whole arrangement of steam passages, etc., forming half of the front saddle for the boiler, would be almost certain to cause very unequal strains upon the working parts, due to warping. The piston packing, and stuffing boxes would have to be fitted altogether with metallic rings, and all the precautions involved in high temperatures and consequent lubri-

cating difficulties should be taken. Doubtless all these points can be provided for, and with intelligent design, all trouble avoided.

An increase of 20 to 25 per cent. in the capacity of the locomotive boiler would be most welcome, since pressures and speeds have been well worked in the effort to increase the capacity without increasing dimensions. The locomotive of the future will doubtless be both compound and superheating, the latter rendering higher expansion ratios possible, without corresponding losses by cylinder condensation.

The Berlin Electric Elevated and Underground Railway.

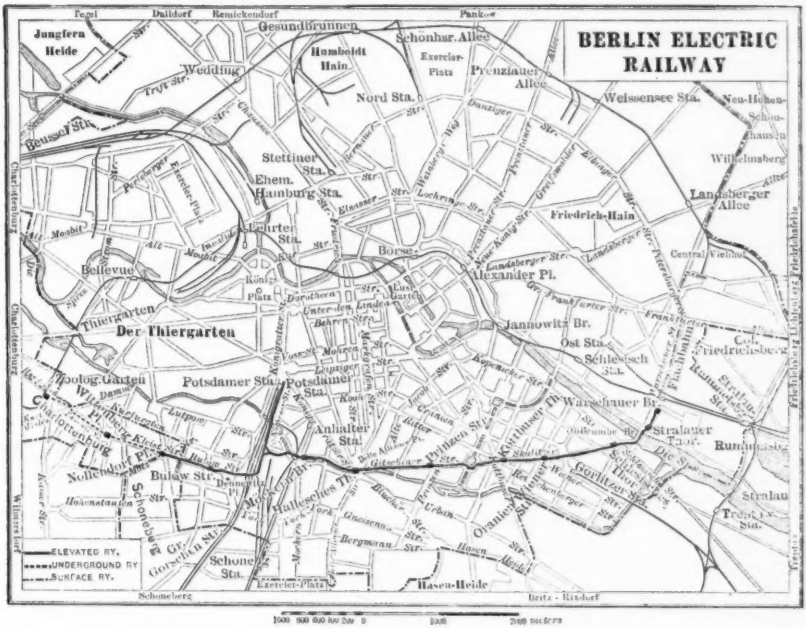
THE growth of Berlin in the last quarter-century has been little short of marvellous, rivalling that of the most progressive American cities, and with the increase in population there has been an even greater development in the intraurban movement on the existing "Ringbahn," street railways and omnibuses. During the years from 1895 to 1899, for instance, while the number of inhabitants increased 13.4 per cent., the city passenger traffic increased 52 per cent., or nearly four times as much. This growth has naturally been accompanied by a demand for increased rapid transit facilities, and various projects for new city railways have been brought forward. The need for an east to west line across the southern part of the city has been most pressing and plans for such a road have been discussed for more than twenty years. From the beginning, this project was fathered by the Siemens & Halske Company and the actual construction work has now been carried out by them in connection with an Elevated Railway Company, formed to finance the undertaking, under a ninety-year franchise, the city reserving the right to buy the road after thirty years.

The first sod was turned in September, 1896, and the road has now been opened for traffic in the early part of the present year. The line extends from the Warschauer Bridge, close by the Warschauer Street railway station, on the east, to the Zoological Garden on the west, a distance of about 9 kilometres (5.5 miles), with a spur, 1 kilometer long, branching north from near the middle of the line to the Potsdamer Place, as shown on the accompanying map taken from the *Elektrotechnische Zeitschrift*, to which and to the *Zeitschrift des Vereines Deutscher Ingenieure* and *Stahl und Eisen* we are indebted for our data. There are thirteen stations, including the last-mentioned one, with an average interval of 900 meters. The underground section of the road comprises about 1400 meters at the western end, from Nollendorf Place to the Zoological Garden, and nearly 400 meters at Potsdamer Place. All the rest is elevated, but at the Warschauer Bridge the road makes connection with a surface line which runs 2 kilometers further to the city stock yards.

The heaviest grade, 1 in 32, is at Nollendorf Place, where the line changes from elevated to underground. Elsewhere the grade does not exceed 1 in 38, and the sharpest curve has a radius of 80 meters.

In order to avoid grade crossings at the "connecting triangle," where the spur to Potsdamer Place branches off, the "up" and "down" tracks are carried at different levels, but all elevated. This rather complicated, but very neat piece of engineering work does a great deal to insure the safe and speedy operation of trains.

The elevated structure is principally of steel, with about one kilometer of masonry viaduct at the Warschauer Bridge end and at the "connecting triangle." The steel construction, in general, consists of light trusses combined with plate and angle columns. The alternate trusses are rigidly connected to the columns, the lower chords ending in curves, which run into the spreading upper portions of the columns, and the other trusses are freely suspended in order to allow for expansion and contraction. The clear height of this part of the structure above the street varies from 3.2 to 5 meters and the trusses have spans of from 15 to 21 meters. Most of the columns are vertical, but in Bülow Street they are inclined outward so as to give a wide enough passage way underneath the structure. There are special constructions at various places along the line, with some highly ornamental features in stone and steel, and in general a great deal of attention has been paid to the looks of the road and to the necessity for making it harmonize with its surroundings.



MAP OF THE ELECTRIC RAILWAY SYSTEM OF BERLIN.

The elevated structure runs through the middle of streets and along the northern bank of the Landwehr Canal. It crosses the Spree River, the Canal and several main railway lines, and in one or two places it cuts through buildings. There is a water-tight flooring of sheet iron covered with gravel or asphalt to prevent drippings and to deaden noise.

The underground portion of the road runs through the middle of the street, right under the pavement. The tunnel is 6.24 metres wide and 3.33 meters high, with concrete floor and sides. The roof consists of transverse concrete arches, between steel beams, which rest on the side walls and on longitudinal girders supported on a line of square columns in the center of the tunnel.

The road throughout is two-track standard gauge. The distance between track centers is 3 meters on the elevated portion and 3.24 meters in the tunnels.

The third-rails, carrying the working current, are between the tracks on the elevated sections and on the outside of the tracks in the tunnels, and in the latter they lie a little higher than on the elevated track, in order to automatically switch on the current for lighting the cars.

Continuous current, at a pressure of 750 volts, is taken from the third rail by contact shoes, of which there are four on each car, two on either side, and the cars are heated, as well as driven and lighted, by electricity.

At present the trains consist of two motor cars, with a trailer between them, but as the traffic increases, another trailer can be attached, or two of these train units can be combined. All the cars have two four-wheel bogie trucks and are 12 meters long over all, and differ only in their interior arrangement. The motor cars are third-class, the trailer, second-class.

The motor cars will ultimately have four motors, one on each axle, but at present they need only three. The motors are four-pole and are powerful enough to give the train a speed of 50 kilometers an hour.

The train is controlled on the multiple-unit system from the motorman's compartment in the front end of the first car. There

is a corresponding compartment in the rear end of the last car, to be used when the train is going in the opposite direction.

Each motor car has seats for 39 persons and standing room for 27, while the trailers have 44 seats and standing room for 30. There are two sliding doors on either side of each car, one to be used on entering, the other on leaving.

The trains run under a 2½ or 5 minute headway, at an average speed of 25 kilometers an hour. The stops at stations take 15 or 20 seconds apiece, and the distance from one end of the line to the other is covered in about 20 minutes.

The current is generated at a power station situated near the middle of the line, by three 800 kilowatt direct-current machines. There is also a storage battery large enough to take the place of one of the dynamos for a full hour, and for shorter intervals its output is even greater. This plant will be enlarged from time to time, as the increase in traffic demands.

The Luxembourg Arch.

For a long time the great masonry arch at Cabin John, on the Washington Aqueduct in Virginia, has held the supremacy for size, and it is only very recently that its 220 feet span has even been approached in magnitude. It is true that there had been in existence the arch of Barnabo Visconti, over the Adda, at Trezzo, of 76.5 meters span, (251 feet) built in 1377, but this was destroyed in 1416, and until now its dimensions have not been again attempted.

Since the experiments upon full sized arches by the Austrian Society of Engineers and Architects in 1895, the laws governing the distribution of pressure in masonry arches have been more fully understood, and the result has been to create a renewed interest in large-span arches. The great railway arch at Jaremcze, by Huss, with its span of 65 metres, (213 feet) nearly approached the size of the Cabin John bridge, and as the latter carries only an aqueduct, and an ordinary footway, the stresses are decidedly less than those of railway service.

Now, however, we have the recently completed arch at Luxembourg, exceeding in span, not only the bridges at Jaremcze and Cabin John, but having even a greater span than the mediæval bridge at Trezzo. With a clear span of 84.65 metres, (277.65 feet) this new arch stands more than 50 feet greater span than Cabin John, and 26 feet larger than the former bridge over the Adda. From a fully illustrated account in a recent issue of *Le Génie Civil* we abstract an account of this important structure.

The City of Luxembourg is situated upon a rocky plateau, surrounded on three sides by valleys of 40 to 50 metres in depth, in which flow the Alzette and its small tributary, the Pétrusse. The slopes of these valleys, especially on the side toward the town, are very steep, so that in former times, especially after the construction of the works by Vauban, in the reign of Louis XIV, it was considered one of the strongest fortified cities in Europe.

In 1859 the introduction of railways into the Grand Duchy of Luxembourg brought up the question of the location of the terminal station, and in order that the strategic importance of the city might not be impaired the station was not permitted upon the plateau, but was built beyond the valley, nearly a mile from the city. Access was had to the station by means of a viaduct of many arches, but the limited width of this viaduct (8 metres) and the demands of increasing traffic have led to its replacement by the new bridge with its great arch. The design which was accepted for the work was that of M. Sejourné, already well known for his construction of the arches of Lavaur (61.5 metres), of Castelet (41 metres), and of Antoinette (50 metres).

Apart from its great span, the Luxembourg arch presents some most interesting features. The width of the roadway was planned to be 16 metres (52½ feet), but instead of making the arch of this width, M. Sejourné designed two parallel arch rings, each of 5 metres width, and with a space of 6 metres between them; the two arches being covered with a platform of reinforced concrete. The spandrels of the arches are left open, with light masonry piers to carry the weight of the floor down to the arch ring, there being a conspicuous absence of any solid backing, formerly considered so necessary to the stability of a masonry arch. The advantages of this double construction are apparent. In the first place the total quantity of masonry required is reduced by more than one-third. In the second place

the centring need be only 5 metres wide, instead of 16 metres, since one arch can be completed entire, and the centring then shifted for the second arch. A notable economy in timber and labour is thus effected. Furthermore the completion of one arch greatly facilitates the work upon the second. With these come numerous minor advantages which appear upon an examination of the work.

A few of the dimensions of the masonry arch are given, and reference should be made to the original paper for further details, including drawings of the entire structure. The span, as given above, is 84.65 metres (277.6 ft.), and the rise is 31 metres, (101.7 ft.) the depth of the arch being 2.16 metres (7.09 ft.) at the springings, and 1.44 metres (4.72 ft.) at the key. The material used is a local limestone, having a crushing resistance, under test, of 1,200 to 1,500 kilogrammes per square centimetre, (17,000 to 21,000 pounds per square inch).

The first of the great arches was completed on July 24, 1901, and the centreing was struck on October 26, when the key sunk only 6 millimetres. The construction of the second arch is now under way.

Progress in Aeronautics.

We have already referred in these columns at various times to the attempts which have been made to solve the problem of aerial navigation by the means of aeroplanes, dirigible balloons, and their various modifications.

Naturally the greater part of recent attention has been directed towards the experiments of M. Santos-Dumont, but these form a portion only of the effort which has been directed of late to the subject. We now have a general review of recent progress in aeronautics, contributed to the *Mémoires* of the Société des Ingénieurs Civils de France, by M. Armengaud, Jeune, from which we make such abstracts as will serve to give a general idea of the present state of the art.

M. Armengaud naturally devotes his attention almost entirely to the subject of dirigible balloons, and while giving full credit to M. Santos-Dumont for his success, shows that it is the natural outcome of the general development of the science of applied mechanics, and especially of the development of the light and powerful motors which have met the demand for automobile vehicles.

It was in 1884 that MM. Renard and Krebs succeeded in demonstrating that a dirigible balloon was a mechanical possibility, and their balloon "La France" must be considered as the pioneer in this direction. At the same time it was impossible at that time to produce a motor sufficiently light and powerful to enable headway to be made against anything but the lightest winds, but enough was done to indicate the lines along which future progress might be expected.

A brief description of the general dimensions and construction of the Santos-Dumont No. 6, with which the successful trial was made, may be given here. The balloon itself was a cylinder of 6 metres in diameter terminating in two cones, the total length being 33 metres, and the displacement being 622 cubic metres. This is equivalent to 800 kilogrammes of air, against which there was to be charged the weight of the balloon, 120 kilogrammes; of the motor, 98 kilogrammes; of the hydrogen itself, 120 kilogrammes; of the aeronaut, 50 kilogrammes, and of various accessories; there being left an unopposed buoyancy of 150 kilogrammes. The balloon was made of the finest white Japanese silk, this being very close mesh, and rendered impermeable by means of five coatings of linseed oil. Within this main gas reservoir there was placed a secondary balloon of 60 cubic metres capacity, this being capable of distension or contraction by the admission or discharge of air, thus maintaining the outer main balloon in its proper shape.

The motive power and propelling machinery were carried on a sort of trussed girder which was attached to the balloon by a system of wires similar to those used in the piano-forte. The rudder, which was of triangular form, was attached to the rear, behind the propeller, and braced and stayed to the frameworks and the balloon by wires. One of the novelties of the apparatus consisted of the use of two reservoirs of very thin brass, containing 45 litres, or about 100 pounds, of water, which might be discharged at will, forming a more controllable ballast than the usual sand bags.

The motor, upon which the principal success of the apparatus depends, was con-

structed by M. Buchet, and contains no especial features differing from the well-known machines of Daimler, de Dion, Panhard, Mors, and others, for automobile service.

We have already reviewed at length the result of the trial of October 19, as well as the trace of the route by M. Armengaud, and hence we may here rather discuss the general conditions which govern the design of light motors for aeronautical service.

Although steam engines have been greatly reduced in weight in the endeavour to secure power and speed in topedo boats, they are as yet unavailable for use in flying machines. M. Serpollet has designed a motor, using his instantaneous system of steam generation, which, for 30 h. p., weighs but 191 kilogrammes, or 6.4 kilogrammes (14.11 pounds) per h. p. It is, however, necessary to carry 10 litres of water (22 pounds) per h. p., which adds too much to the load for aeronautical purposes. The principal method by which the weight of a steam motor may be reduced is by increasing its speed, and in this respect the steam turbine offers possibilities.

MM. Renaud & Krebs used a battery and motor of 9 h. p., with a weight of 25 kilogrammes per h. p. hour (55 pounds), and this was a great advance over the 68 kilogrames per h. p., of M. Tissandier, or the weight of the eight men, (400 kilogrammes) employed by M. Dupuy de Lôme.

In order the better to show the reduction in weight per horse power which has been attained in the more recent internal combustion motors, M. Armengaud gives a diagram in which the curves show the results of various makers. Without going into details it may suffice to state that for motors of 50 h. p. the weight has been reduced to 5 kilogrammes (11 pounds) per horse power, while for motors as large as 100 h. p. this may be reduced to 3 kilogrammes (6.6 pounds) per horse power.

Referring to the points to be observed in the construction of future dirigible balloons, it will be interesting to note the rules laid down as long ago as 1886 by Colonel Renard, as a result of his practical experience. In order to obtain successful results it is desirable to:

1. Give the balloon an elongated form, similar to that of a boat;

2. To maintain the form of the balloon by the use of an internal vessel, permitting the replacement of the gas by atmospheric air;

3. To maintain the longitudinal stability by connecting the car to the balloon by a rigidly braced framework;

4. To use a propeller of suitable dimensions, actuated by a motor of as great power, and relatively light weight as possible;

5. To place the rudder in the rear, in a manner similar to that employed in steering boats.

To these rules Mr. Armengaud adds some of his own, based upon the most recent experience.

1. Employ an internal-combustion motor having at least four cylinders, in order to permit the best degree of balancing, and to use electric ignition, in order to avoid interruptions in the action of the cylinders.

2. Bring the propeller shaft as close as possible to the longitudinal axis of the balloon, that is, to the line passing through the centre of pressure.

3. Provide sufficient distance between the centre of pressure and the centre of gravity of the system to maintain operative stability.

4. Provide, in the case of small aerostats, an auxiliary couple for stability, by the use of a guide rope or a movable weight.

5. Provide an easily regulated motor, in order to enable the sudden variations in resistance to be met promptly.

6. In the case of large machines, to provide two propellers, one in front, and the other in the rear, each propeller being actuated by an independent motor.

Space Telegraphy.

At a recent meeting of the Société Internationale des Electriciens, Captain Ferrié of the French military telegraph service, read a paper on the present state of wireless telegraphy with Hertzian waves.

After reviewing the history, the principles and the theory of space telegraphy, the author discussed some of the difficulties met with. The parasitic signals due to atmospheric and terrestrial electrical phenomena, encountered by himself and other experimenters, he divides into three classes: First, those caused by lightning discharges, which are sometimes perceptible at great distances. For instance, during experiments carried on

in the environs of Paris, signals were registered caused by a thunderstorm at Angers, nearly 250 miles away, while the sky was absolutely clear at Paris. But these disturbances are of minor importance.

Second, those due to variations in potential of the earth plate and the upper part of the receiving wire caused by changes in the earth's field. Parasitic signals have frequently appeared at sunset and disappeared about 30 minutes thereafter, and are also caused by the passage of electrified clouds. By connecting the receiving wire directly to earth, as in the newer arrangements of Marconi and Slaby, that part of these disturbances due to slow variations of potential, can be eliminated.

Third, those which appear to bear relation to the temperature, and are met with in warm climates, beginning about ten o'clock in the morning and lasting until evening and sometimes completely preventing any communication between stations. These disturbances were encountered by Marconi in his work between France and Corsica.

All these influences are more apparent the higher the wires and the more sensitive the coherers, and a large part of them may be avoided by using coherers of a low degree of sensitiveness, though this remedy introduces other disadvantages, notably a diminution in the range of communication.

Several methods of syntonizing, or tuning apparatus are described, particularly those of Marconi and Slaby. These all consist essentially in regulating the period of the ether waves by putting definite amounts of inductance and electrostatic capacity in the oscillating circuits.

By tuning the transmitting and the receiving apparatus to the same pitch, a maximum amount of energy is made available at the receiver and greater effects can be produced and longer distances covered, but owing to the phenomenon of multiple resonance, no system of syntonization can prevent the receiving apparatus from being affected by waves of any pitch provided there is enough energy in them. According to this view, a powerful transmitter, working at a definite pitch, would affect receivers of all pitches situated within a limited radius, but at greater distances it would affect only those receivers which were tuned to the same pitch. For instance, a very powerful transmitting apparatus at Cornwall would cause transatlantic receivers to respond only if they were carefully attuned to it, but would affect receivers of all pitches along the English coast and in the English Channel. It would be interesting to know if any such effects were actually observed during recent transatlantic experiments.

On Marconi's latest voyage to New York on board the "Philadelphia," he received messages from Cornwall at a distance of over 1,500 miles and signals at over 2,000 miles, while it is stated that the instruments on the "Umbria," which followed close after, were entirely unaffected.

As a matter of fact, both Marconi and Slaby have received simultaneous messages on the same vertical wire, with two sets of receiving instruments tuned to very different pitches, over comparatively limited distances, but better results are obtained by having as many vertical wires as there are receiving instruments.

This question of syntonization is the crucial one, whose more or less perfect solution will determine the adaptation of wireless telegraphy to general purposes.

The objection that wireless telegraphy cannot insure secrecy is not of such great weight, for this disadvantage is more or less common to all methods of electric communication. Wires have been tapped, and "listening in" is not an unheard of occurrence in telephony. Code systems can obviate this objection, but a more serious trouble is the possibility of interference. If all the small stations have to "shut up" when a big one is shouting in their neighborhood, the practical limitations of space telegraphy are apparent, but whatever the final outcome of the work to secure perfect syntony, there will still remain a large and important field which space telegraphy will have all to itself. For communicating with ships at sea, with isolated lighthouses and with islands which cannot be reached by cable, its advantages are unique.

It seems as if there were room enough for all our systems of electric communication, and it is most probable that the net effect of wireless telegraphy upon the older methods will be an all-around improvement, such as was experienced by the gas industry after the introduction of electric lighting.

Studies in Radio-Activity.

We have referred several times in these columns to the curious phenomena which have been observed in connection with the rays emitted from certain metals (uranium, polonium, radium, etc.) and their compounds, believing that while these subjects belong at present to the domain of physics, their study may ultimately reveal many things of importance to the applied science of engineering. Much of the original research in this line has been done by the well-known physicist, M. Becquerel, while many of the latest developments are due to the careful work of M. and Mme. Curie. In a recent communication to the French Academy, made by M. Becquerel on behalf of M. and Mme. Curie, and published in the *Comptes Rendus*, we have some most interesting points upon the subject, which are briefly reviewed here.

In order that investigations may be conducted with method it is necessary to adopt some provisional theory, and then proceed with experiments which may serve to prove or disprove the assumptions which are involved. The theory upon which the present studies have been based assumes that the radio-activity is an atomic property of the substance. Naturally the most important point for examination is the assumption that each atom of the substance acts as a constant source of energy. This fact may be determined by means of a great variety of experiments upon the radiant energy, without demanding the discovery of the source from whence that energy is derived.

Experiments conducted through a number of years have demonstrated that for uranium, thorium, radium, and probably also for actinium, the radio-activity is entirely uniform when the body is maintained in the same chemical and physical condition, and that this activity is not diminished with the lapse of time. Polonium forms a curious exception to the above conditions. Its radio-activity slowly diminishes with the lapse of time, and the rays emitted differ from the others in that they are not deviated by a magnetic field, nor do they appear to be capable of inducing radio-activity in other substances.

Two theories have been advanced as to the source of the energy emitted by these substances. One theory assumes that each atom possesses in a potential condition the energy which it radiates, while the other assumes that the radio-active atom acts as a mechanism which draws each instant from without the energy which it disengages. The first hypothesis involves the assumption that the energy must eventually be exhausted, although the experience of several years has thus far failed to detect any variation. If we admit the supposition of Professor Crookes and Professor J. J. Thomson that the cathode rays are material, we may conceive that the radio-active atoms are in course of transformation. Experiments upon these points have thus far yielded only negative results. After an emission of four months there has been observed no appreciable diminution in the weight of the radiant substance, nor has there been seen any perceptible change in the spectrum.

The second hypothesis, on the contrary, assumes the radio-active body to be acting simply as a transformer of energy. This energy may be borrowed from the surroundings in the form of heat or it may be borrowed from unknown sources by means of radiations as yet undiscovered. It must not be forgotten that we are doubtless placed in the midst of many phenomena of which we are altogether ignorant, since our knowledge is limited to those things which are capable of acting upon our senses, either directly or indirectly.

The work which has thus far been done in this interesting field is an excellent example of modern methods of scientific investigation. When certain unknown phenomena are to be investigated various methods may be followed. Very broad and general hypotheses may be made, and then gradually narrowed in accordance with the results of experiment. This methodical advance is the most reliable, but it is also the slowest. On the contrary, one may make much bolder hypotheses, in which the mechanism of the phenomena may be assumed, and then far more definite experiments may be undertaken in order to test the correctness of the assumptions. At the same time one is apt to be led into error by the very necessity of making a working hypothesis, and indeed it must be expected that such a method must consist of a mixture of truth and error.

REVIEW OF THE AMERICAN PRESS

The Evolution of Fire Arms.

THE relation of military weapons to the advancement of civilization is a subject which has often been discussed, but at no time more effectively than in a recent paper presented before the Franklin Institute by General Joseph Wheeler, U. S. A., and published in the *Journal* of the Institute.

General Wheeler traces the use of gunpowder back to the East, where, in soil impregnated with nitre, the charcoal from a fire might well have been the cause of a flash which led to the discovery of the explosive. The written history of the use of firearms is lost in obscurity, but it appears certain that such weapons were known in Asia long before they became known in Europe.

Although cannon were used at Crecy in 1346, the long bow and the cross bow remained the superior weapons for a long time, and even so late as 1792, the archer proved himself a better marksman than the musketeer, in a trial at target shooting. The whole history of the development of weapons shows that improvements were made by laymen, and neglected or even opposed by military men until the latter were compelled to adopt them.

Thus the Napoleonic wars were fought with the old flint-lock musket, although the percussion lock was invented in 1800, and patented in England in 1807, so that with this greatly improved weapon in his possession the Duke of Wellington went into the battle of Waterloo, eight years later, with the muzzle-loading flint lock. But this was not all. In the face of abundant information that breech-loading arms had been before the public for centuries, and despite the fact that the percussion lock was publicly advocated in 1807, and in general use in Europe from 1838, and manufactured in the arsenals of the United States government in 1844, the army of General Scott in the Mexican war was armed wholly with flint-lock muskets. Quoting the sarcastic remarks of Captain Kimball:

"The English bowmen made a gallant stand against the ignominy consequent upon the use of the brutal musket; the French bravely rejected the breech-loader in the Napoleonic wars; the Americans did nobly in refusing to use percussion-lock guns in Mexico, and in greatly preferring wonderfully bad muzzle-loaders to comparatively effective arms with which to kill each other during the Rebellion; but all these heroic attempts at stopping military progress fade into insignificance when one contemplates the glorious resistance to the utilizing of magazine mechanisms upon the rifle."

It would seem difficult to account for these repeated anomalies, but when we reflect that armaments are selected by experienced soldiers, and that they have been indelibly impressed with the excellence of weapons which they have used, and that they realize that any change would require a new course of instruction, and at the same time involve great expense in the change of armament, some idea is conveyed as to the reasons why they desire to adhere to old systems and weapons.

Even in late years, when a hammerless gun was offered to the government, officers of distinction urged as a serious objection that it would be impossible for the soldier to come to support arms. It seemed not to have occurred to them that the manual of arms could be changed and that there was no necessity for ever holding a gun in such a position.

Coming down to the present, General Wheeler shows the dilatory conduct of the United States in connection with modern firearms and smokeless powder.

Smokeless powder was invented prior to 1886 and was in general use in Europe soon after that date.

It was adopted by the United States, together with the Krag-Jorgensen, in 1892, and yet in June, 1898, every infantry vol-

unteer regiment went to Cuba as an army of invasion armed with the old Springfield rifle with black powder cartridges. The Spanish had smokeless powder and the Mauser rifle, which many experienced officers regard as better than the Krag-Jorgensen. Even in the far-off Philippines, the insurgents were armed with the Mauser and Remington.

But what is still stronger evidence of this too conservative spirit, notwithstanding that smokeless powder has been used for heavy guns for ten years, black powder, with its clouds of smoke, was the only kind furnished to Dewey at Manila, or to Sampson, Schley and Clark at Santiago, and the "Brooklyn" was so enveloped in a mountain of smoke that officers on adjacent ships only knew that the Brooklyn had not gone to the bottom by hearing the thunder of her guns as this noble cruiser hurled tons of iron missiles into the Spanish ships.

The present line of improvement lies in the development of non-recoil and automatic guns. The principal cause of defective aim has been in the derangement due to the recoil after each discharge. Since increased power is attended with increased recoil, and since the limit of endurance has already been reached, it is evident that this must be neutralized, if not utilized, if further improvement is to be made. With such guns the soldier can keep his eyes directed constantly upon the enemy, and vary the direction according to the slightest indications. With this is required rapid fire and a high degree accuracy, and the army which is fully provided with such weapons will have a vast superiority over its opponents.

In the future, war must be conducted upon business principles. The use of a non-recoil, semi-automatic rifle, and thorough drill and instruction of the soldier, will entirely change this very unsatisfactory condition. The effort should be to so train an army that the missing of a shot would be the exception and not the rule, as it has been with the old recoil gun. We may not reach such a perfect degree of excellence, but we can and certainly will approach it.

Science and scientific skill now enter into every civil vocation. What has heretofore been accomplished by the exercise of manual strength is now done with a thousand or more times the ease with which it was formerly done by human effort. To-day, one man by the control of steam or electric power does work which a few years ago required the combined strength and exertion of a thousand or more human beings.

The nations which will win victories in the future will be those who use the most skill in the application of scientific methods and scientifically made arms, ordinance and other machines of war.

Methods of Illumination.

In an interesting paper recently presented before the American Institute of Electrical Engineers, Dr. Louis Bell discusses the art of illumination from its human and practical side, although he naturally devotes most of his subject to electric lighting.

After commenting on the tremendous increase in resources in illumination since the time of the once brilliant fetes of Louis XIV, Dr. Bell shows that with the immensely powerful sources of light now at our command, there is a constant and often reprehensible tendency to turn on more and more light, irrespective of quality and regardless of physiological and physical effects, thus keying up the vision to a pitch which demands extraordinary methods to produce common-place results.

The true end of artificial lighting should be to furnish illumination in quantity fully adequate for the conditions to be met, and in quality such as will neither unduly strain the eye nor in any way inconvenience the user. Thus quality is more important than quantity, and it is this feature which Dr. Bell seeks to emphasize.

The important qualities for a practical illuminant are: steadiness; suitable intrinsic brilliancy; and suitable color. Steadiness is placed first, and its importance cannot be too highly estimated, since without it the other properties are valueless. Visual inertia acts, by virtue of the property of persistence of vision, as a protection against very rapid changes, but not against slower ones, and there is a wide range of frequency below the point where visual inertia fails to protect and the point where the iris can give aid by its changes in aperture. This effect naturally varies with different persons, but Dr. Bell finds that in his own case a variation of 10 per cent. at

the rate of one or two maxima per second is very annoying and tiring. This is an important element in the production of satisfactory lighting by incandescent electric lights. The question of intrinsic brilliancy is most important in its physiological effects, since the image of a brilliant light acts to produce serious inflammation if too long continued in one spot. If the image wanders over the retina, or moves quickly in and out of the field of vision, very unpleasant results are produced. The fundamental rule of proper illumination, therefore, is to keep brilliant radiants out of the field of vision. It is for the above reasons that a shading of the light, while diminishing the brilliancy, may greatly improve the seeing conditions. Experiments upon a number of sources of illumination show that for radiants within the field of vision at the distances ordinarily met in interior lighting, an intrinsic brilliancy of 5 c. p. per square inch is about as high as it is wise to go. If this is secured from direct sources it involves the use of diffusing globes of fairly large dimensions, but the better plan is to use arcs kept out of the working field of vision, and acting by reflection from the walls and ceilings of the rooms. In this latter case much depends upon the color and surface of the walls, and this important matter should be considered in connection with the system of lighting to be employed, especially in halls and places of public assembly.

In considering the question of color, it is usually unnecessary that any particular standard be adopted, but at the same time broadly colored lights are not desirable. It is the orange, yellow, and green that make up about 80 per cent. of the useful luminosity of the solar spectrum, and the energy required to produce a brilliant blue or red would be far more than for the same luminous effect in yellow or green. Naturally sunlight is the proper standard for the best work of the human eye, but this is a very variable quantity and can only be approximated.

Dr. Bell discusses the various sources of light, gas and electric, in accordance with the requirements above indicated, and gives some valuable hints as to the choice of illuminants for different conditions. For these we must refer the reader to the original paper only emphasising here again the important facts, that steadiness, and distribution are far more valuable than great brilliancy, that the human eye is the evolution of ages of illumination such as we now find in ordinary daylight, and that this natural standard should not be departed from more than is absolutely necessary.

The Powering of Electric Trains.

At a recent meeting of the American Institute of Electrical Engineers, Dr. Cary T. Hutchinson read a paper which was interesting in itself, but even more so from the discussion which it provoked, both at the meeting and in the technical press. This paper was entitled "The Relation of Energy and Motor Capacity to Schedule Speed in the Moving of Trains by Electricity," and it gave a general solution of the question involved in the movement of a body from rest to rest with velocity varying as in the typical case of car acceleration, namely: first, a uniform acceleration while getting up speed; second, a uniform retardation after the power is shut off and the car, or train, is "coasting"; third, a uniform retardation at a higher rate while brakes are being applied, until the train comes to rest.

The solution aims to afford a means of determining the energy, the power and the losses for any schedule speed, over a course of any length, with any initial acceleration, tractive resistance and braking effort, and with any desired use of the "motor curve," the latter showing the values of torque and speed for various inputs.

The method is partly analytical and partly graphical, and in order to solve the problem by mathematical formulæ, it was necessary to make various simplifying assumptions. Thus, for instance, the track is assumed to be absolutely straight and level, the train resistance constant for all speeds, and the acceleration and retardation uniform. Now, the validity of these assumptions was most strongly criticised, and it seems to be a fairly general opinion that the variations in actual operations from Dr. Hutchinson's ideal conditions are so great that his conclusions can be of little practical value. It is, perhaps, doubtful whether so complicated a problem as the one he attacked can have any useful general mathematical solution, but he appears to have

gone as far in that direction as possible, and at the very least, deserves credit for having put the subject in concrete shape for a very useful discussion.

Dr. Hutchinson reaches the conclusion "that the acceleration that gives the lowest motor capacity per ton is in all practical cases the most economical. The very small saving in energy is not to be compared with the many disadvantages of very rapid initial accelerations. Assume, for instance, a gain of 10 watt-hours per ton mile for an acceleration of 3, over that required for an acceleration of one; for a 20-ton car, and with energy at 0.5 cent per kilowatt-hour, this represents a saving of 0.1 cent per car-mile. This is too trifling to be considered in comparison with the fixed charges on the greater investment for motors and distribution system; the poorer load factor at the power station, the increased cost of maintenance, the difficulty of accurate handling of cars, and, above all, the much greater discomfort to passengers."

The broader question of the successful operation of electric railways involves much more than the attainment of a certain schedule with the lowest possible energy expenditure. The argument in the concluding part of the last paragraph might go even further and say that the energy consumed by the motors of a train represents only a part of the cost of operating a road, and when all the fixed charges are taken into consideration, perhaps not a very important part of the total expenditure. As has been said in one of the critical articles on this topic, "electric railway operation is much more than a problem in kinetics," and, we might add, dynamics as well. In the end, it is a matter of business and common sense, where all parts of the problem are given proper weight. The object of a road is to build up a paying traffic, and to secure this a satisfactory train service is of the first importance. Good engineering is of course most necessary, but slight savings in energy consumed are of minor importance compared with the convenience and comfort of passengers. A train service should be reliable, safe, comfortable and as speedy as possible, and when these objects have been attained, the question of the energy expended in moving the trains can almost be left to take care of itself.

The Premium System of Wages.

THE premium system has been much discussed from various points of view, and naturally there have been various objections made to it both of theoretical and practical grounds. In a recent address delivered before the students of Cornell University by Mr. F. A. Halsey, the originator of the system in the United States, some of these objections are considered and answered.

The fundamental principle of the premium system is that of inducing the workman to save time by giving to him a portion of its value, and, as Mr. Halsey well says, the first question is to determine what proportion of the value of the time is to be given to the workman who saved it. The matter must rightly be considered as a bargain, in which each party endeavours to get as much as possible for what he gives the other. From this point of view it will be seen that the premium is in no sense a bonus of gratuity, but that it is, in the fullest sense of the word, an earning. Assuming, then, that the premiums are settled upon a basis of increased output, there is no reason why they should be cut from time to time, and that so long as the methods of production do not change, the rates may be made permanent. Indeed, if cuts are introduced, there is at once produced the principal evil of piece-work and the workman's confidence is destroyed and with it the incentive to further effort.

The most fundamental objection is that which denies that time is the proper measure of wages, and insists that it is only the product which is of value; this leading directly to the position that piece-work is the only sound method of remuneration. This position is naturally that of the employer, since it is upon that basis only that he can obtain results for what he sells. The workman, however, has his time to sell, and naturally considers it the proper basis of payment. In other words, both employer and workmen are in business, the latter selling his time to the former, and the former selling the products of the latter's labor to the customer. Thus, as Mr. Halsey well says: The employer's interests are with low wages per unit of product, while the workman's interests are with high wages per unit of time. The premium plan at-

tempts to make these interests as far as possible identical. Its true object is to provide increased wages per day with reduced wages per unit of product.

Another objection is that made from the standpoint of equity. It maintains that the increased output is due entirely to the efforts of the workman, and sees no reason why he should receive only a part and that the lesser part of the resulting gain. This objection must be met in the original position that the workman is in the business of selling his time to the employer, and that the law of supply and demand will operate to compel the employer to meet competition by reducing his selling price to the extent to which he at first shares in the gain, so that the gains due to the operation of the system will ultimately be divided between the workman and the purchasing public.

There is one feature here, however, which must be taken into account, namely, the difference in the nature of the workman's commodity, time, and the employer's commodity, merchandise. The latter can be stored, and held for a considerable period without losing its selling value, while the workman's time is a vanishing quantity, which he cannot store, but which he must sell day by day. A day's work, if not sold, is gone forever.

As opposed to the position that the value of a man's time is measured by its product, comes that which insists that the time value is fixed by the market rate, and that any more is a gratuity, and not wages. There is a market value of time, it is true, but that value is only to be had by proper management, and the mere presence of the workman in the factory without the provision of duties and direction of incentive, will not enable it to be realized.

Another objection is one commonly made, that the premiums are not intended for permanent use, but are only intended to be used to discover a man's capabilities, after which the reward will be removed and the production under the premiums still demanded. This corresponds to the standing objection to piece work, that is, the cutting of rates. It is answered by the standing fact that experience has long ago shown that the workman is worthy of his hire. All employers pay higher wages to efficient than to inefficient workmen, because compelled to do so. The premium plan simply systematizes this practice and grades, sorts, and pays men in accordance with their efficiency, instead of leaving that sorting to general observation, and even to favoritism. An employer can no more get the premium output without the premiums than he can get an efficient workman for an inefficient workman's wage.

In many establishments it is considered desirable to place the judgment of what constitutes a day's work in the hands of old and experienced workmen, assuming such to be safe guides, upon whom managers can depend, and by whose judgment foremen can be required to get the output of the men under them. If working conditions remained constant, and men lived forever, this might be a good method, but experienced men pass away, and operative conditions change, and we hope, improve, both for men and for employers. The premium system endeavors to determine the proper remuneration by the actual operative conditions, and from its very nature should grow with them, thus rendering the determination of a day's output a function of the actual conditions under which it exists, and not upon the experience of what has been in existence in past times.

If the industrial system of the world is, in a broad sense, simply the co-operative production and distribution of wealth, and if an increase in the total wealth produced, by giving more to divide, increases the amount available for each individual, the general adoption of the premium plan can do nothing less than advance the prosperity of all.

Artificial Graphite.

THE production of carborundum in the electric furnace by the fusion of sand and coke and their conversion into silicon carbide is well known. In the course of this work it appeared that a certain proportion of pure graphite was produced, and since this product had a commercial value, experiments were conducted by Mr. Acheson, with the result of making artificial graphite a regular commercial product of the electric furnace.

In an article in a recent issue of the *En-*

gineering and Mining Journal, Mr. F. A. J. Fitzgerald discusses the process and shows the uses of the product.

In his patent, Acheson states that the graphite is really produced by the indirect conversion or dissociation of the carbon from combination with other materials, and shows that the product is enormously increased by mixing the carbonaceous material with a certain proportion of oxides of iron. The furnaces used in the process for making graphite and graphite electrodes commercially are similar in outward appearance and magnitude to those used in Acheson's process for making silicon carbide. They are built of brick in the form of a long, narrow trough lined with some suitable refractory material. In making graphite electrodes the latter are manufactured of petroleum coke and pitch like an ordinary carbon, such as is used in arc lights, but a certain amount of some carbide-forming material such as silica or iron oxide, is introduced. The electrodes are baked in the usual way, and are then ready for graphitization. To perform this operation they are placed in a furnace and heated to a temperature well above that of the volatilization of such bodies as iron, aluminum and silicon. That the temperature in the furnaces is well above this point may easily be demonstrated, as the bodies above named are condensed in the form of their oxides outside the furnace.

The carbonaceous substance which has been found most suitable for making graphite is anthracite coal, when the ultimate product is to be paint, crucibles, and similar work. When graphite electrodes are to be made, a petroleum coke or pitch is used, this being mixed with silica or oxide of iron, and the mass baked in the usual way before placing in the electric furnace. The advantages of artificial graphite over the amorphous variety is shown in the fact that the density of the latter is only 1.90, and compared with 2.19 for the artificial graphite, while the respective electrical resistances per cubic inch are 0.00124 ohm, and 0.00032 ohm.

Tests made on the graphite produced from anthracite show that it is free from amorphous carbon. The average product of the furnaces contain approximately 5 per cent. of ash, and is therefore far purer than the average natural graphite. When necessary, purer graphites are produced; this being done by heating to a high temperature for a sufficiently long time to volatilize and drive off all impurities. Anthracite treated in this way produced a graphite containing only 0.31 per cent. of ash, although the original coal carried about 15 per cent. ash. This small residual ash is undoubtedly due to the condensation of the vapors existing in the furnace when the current is cut off.

It is a remarkable fact that in spite of the large amount of work that has been performed by various experimenters on the conversion of amorphous carbon into graphite, half a century elapsed before a process was developed that is now becoming of greater importance every year. Over 50 years ago with a battery of 600 Bunsen cells Desprez attacked this problem; but it was only a few years ago that a method was discovered by which, in the first year of the new century, and with the electric current produced by the Niagara Falls, nearly 2,000,000 pounds of graphite were manufactured from amorphous carbon.

Electrodes, made of artificial graphite, are recommended for electrolytic and electrometallurgical processes, and the advantages claimed for them are long life, low porosity, high conductivity and great economy. The electrodes are made by treating in the electric furnace amorphous carbon articles made up in the shape desired. The product is stated to be entirely free from amorphous carbon, and the percentage of impurity in the finished electrodes is given as 1 part in 1,000. The size of the electrodes is limited generally by the difficulties of manufacture. In rectangular shapes the cross section is limited to about 28 square inches, and the length to 36 inches. The width of a carbon is usually limited to 8 inches. In round carbons the length is limited to 36 inches, and the diameter is 5 inches. These limits can be increased slightly when large amounts are ordered. Some striking results have been obtained in tests made in Germany with graphite electrodes in the electrolysis of sodium chloride solutions.

The production of artificial graphite is but another of the developments of the application of electricity to industrial technology, and doubtless many other sub-

stances will be added to the products of the electric furnace in coming years. The growth of the electrochemical industries gives another indication of the transformation which is overtaking the work of tne technical chemist. Indeed it is well understood in the United States that establishments which are as yet not prepared to abandon the older methods of producing various chemical supplies, are acquiring interests in hydro-electric power plants in eligible localities in order to be prepared for the inevitable transformation which can be foreseen. Such plants can be made to pay their expenses by the supply of current for local industries until such time as they may be needed for the special uses which their projectors had in mind, thus requiring no charge against present operating expenses to be made on their account. It is in methods of this sort that the combination of the engineer and the business man gives a strength which must be lacking in either considered separately.

Notes on the Isthmian Canals.

In a very interesting address delivered before the Chicago Commercial Club, and published in the Railroad Gazette, Mr. George S. Morison gave some points of interest in connection with the Isthmian canal projects which are here reviewed.

After comparing the constructive features of the Nicaragua and Panama routes, Mr. Morison shows that the main advantage of the Nicaragua route is that the west end of the Nicaragua canal is 500 miles nearer San Francisco than is Panama. This is a manifest gain for communication between New York and the Pacific ports, but it is nearly neutralized by the additional time required for the passage through the Nicaragua canal.

Mr. Morison calls attention to some interesting facts about the distances involved in traffic through an isthmian canal. Says he:

"We all measure our longitude from Greenwich; Greenwich is practically London. The Mississippi River, as marked by St. Louis, Memphis and New Orleans, all of which are on the same meridian, is in longitude 90 degrees west. The mouth of the Ganges is in longitude 90 degrees east. The mouth of the Mississippi is directly opposite the mouth of the Ganges. The mouth of the Mississippi is almost north of where the Isthmian canal would be. The mouth of the Ganges is a long way east of the Suez canal. This means that very little business can be expected to go from any European ports through the canal across the American isthmus. This canal must stand on its own merits. It must be a canal for American traffic. Furthermore, our Atlantic ports can reach Chinese ports by a little shorter route through the Suez canal than across the American isthmus. Manila is about equally distant by both routes. Japan would be nearer by the American isthmus.

"Another thing: a great circle curve drawn from the terminus of either canal to San Francisco would be almost entirely on land, it would pass through New Mexico; the shortest route by which any vessel could go from the terminus of either canal to Japan would take them so near to San Francisco that San Francisco would naturally be a coaling port. The distance from Panama to Yokohama, by way of San Francisco, is less than by way of Honolulu, San Francisco, furthermore, is the one port on the west coast of America which is nearest, not only to China and north Asiatic ports, but to Australia and New Zealand. There are some curiosities of this kind which it is important to think about.

"From New York to San Francisco is 5,144 miles by way of the Panama canal. A 15-knot ship going 360 miles a day would make that trip in about 15 days, including the canal, if everything was all right. From Plymouth, which may be taken as a sample European port, the distance is 7,674 miles; that would take 21 days; including the canal, probably with coaling, etc., 23. The opening of the canal would place our Pacific coast in direct communication with our Eastern coast and with Europe. It would place our Eastern coast and the Mississippi Valley in direct communication with the west coast of South America, the trade of which is now held in European hands. This is a thing to which little attention has been given, but it is likely to prove a very important one. But after all, I know of nothing which you can rely on less than statistics of transportation on a transportation route which does not exist. The profits and the business of the canal must be the

results of conditions which that canal will create. The French company made very nice calculations based on the position of ships all over the world for several years. But the real fact is that the opening of this canal will encourage certain interests on our west coast and elsewhere, which cannot fail, in my judgment, to change many lines of trade, and to create traffic which does not now exist. If it were only to be the traffic which does exist, I should doubt the expediency of building the canal."

In regard to the military question, the canal, in Mr. Morison's opinion, would be an important factor in the prevention of war. In all probability fleets could not be taken through the canal in time of war.

But the value of a fleet is not so much to fight in war, as to prevent the occasion of war; and the exercise and duties which an American fleet could perform with the existence of a canal, the change of stations and the discipline of squadrons, would be very greatly improved. Our fleets would be much more effective, not perhaps in fighting, but in preventing the necessity of fighting.

The Ethics of Patents.

THE ethics of the engineering profession is wrapped in a mist and haze which no one need hope to dispel, but a new feature has recently been brought out by a brief communication in the Proceedings of the American Society of Civil Engineers concerning the question as to whether it is unprofessional for an engineer to be a patentee. The writer, Mr. A. R. Eldridge, seems to have forgotten his ethics so far as to permit himself to poke fun at the dignified society; and, assuming himself to be in a benighted condition, he appeals to the membership for light.

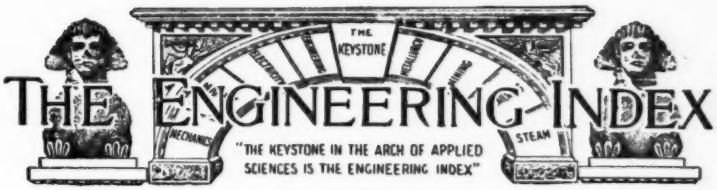
After stating that he himself has not violated the ethics of the profession so far as to apply for a patent upon any article whatsoever, not even for a washing machine nor a car coupler, Mr. Eldridge proceeds to inquire as to the reasons involved in the extraordinary idea that it is unprofessional to become a patentee.

Let it be supposed that an eminent engineer, one of the leading lights of the profession, should, by chance, stumble upon a decided improvement in egg beaters. Would he debase the ethics of his profession by taking out a patent on his invention? It is hardly to be supposed that the engineering world would decry such an action; why, then, should it object to his taking out a patent on a new and improved method of rolling steel rails, on an improvement in the valve gear of a steam engine, or on the construction of a freight car? It the ranks of the profession were scanned carefully it would doubtless be found that many eminent engineers and scientists have taken out patents; witness the names of such men as Lord Kelvin, Captain John Ericsson, Professor Rankine, and others, not to mention numerous members of the American Society of Civil Engineers. Mr. Eldridge, however, strikes a very happy point when he compares patents and copyrights.

"One does not see or hear of any objection being raised when an engineer copyrights a book which he writes, or even compiles, yet wherein is to be drawn the fine distinction between a patent and a copyright? An article, a device, a method of manufacture may be patented, whereas a book may be copyrighted. In either case others than the owners of the patent or copyright are restrained from using the article or the contents of the book without compensation in one form or another, being paid to the holder of the patent or the copyright."

Especially pertinent is the fact pointed out that the Proceedings of the American Society of Civil Engineers are themselves copyrighted, so that the whole society as a body is continually doing that which some of its individual members would have us believe is in violation of the ethics of the profession!

It is indeed refreshing to see such solemn nonsense brushed away in the clever note of Mr. Eldridge, and to call attention to the manner in which an attempt to revive obsolete notions as to the unprofessional character of patents has been met. As a matter of fact there is no earthly reason why a civil engineer should not patent any original inventions relating to his profession just the same as any other man. He is in business, and is prepared to receive fees for his knowledge and work, and any attempt to make the blunder of pretending that he is not in business for its legitimate returns can only result in making him ridiculous.



The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title, (2) The name of its author,
(3) A descriptive abstract, (4) Its length in words,
(5) When published, (6) Where published.

We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Masonry Arch Bridges at Trenton and New Brunswick, New Jersey; Pennsylvania R. R. Illustrated details of two new bridges to be built during the present year. 900 w. Eng News—Jan. 30, 1902. No. 45912.

The Fern Hollow Highway Arch Bridge. Illustrated description of a struc-

We supply copies of these articles. See page 159.

ture 50 ft. wide over all, of which the main feature is a 195-ft. span with two 3-hinge plate-girder arch ribs and vertical spandrel posts 24 ft. apart to support the roadway deck. 2900 w. Eng Rec—Feb. 15, 1902. Serial. 1st part. No. 46260.

The New Luxemburg Stone Arch (Le Nouveau Pont de Luxembourg). Aug. Dutreux. A well illustrated description of the largest stone arch in the world, 275 ft. span, carrying a wide highway into the city of Luxemburg. 1 plate. 2000 w. Génie Civil—Jan. 18, 1902. No. 46340 D.

Brooklyn Bridge.

The Safety of the Brooklyn Bridge—A Rejoinder by Messrs. Hildenbrand and Henning. 4200 w. Eng News—Jan. 30, 1902. No. 45914.

Colonial Bridges.

Colonial Bridge Erection. Discusses types, the influence of climate, and other conditions. 3500 w. Engr, Lond—Jan. 31, 1902. No. 46131 A.

East River Bridge.

The Triangulation for Bridge No. 4 Across the East River, New York City. Oscar Erlandsen. Describes the novel methods used in obtaining the distances across the channels in the Blackwell's Island Bridge. Also the apparatus and results. Ill. 1500 w. Eng News—Feb. 13, 1902. No. 46194.

Flooring.

Experiments on the Strength of Wooden Floor Construction of Suspension Bridges (Versuche über die Tragfähigkeit der Hölzernen Fahrbahnconstructionen von Hängebrücken). A review of an article by M. Pierret in the *Revue Général de la Construction Métallique et de la Serrurerie*, giving the results of experiments on French highway bridges. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 4, 1902. No. 46350 B.

Masonry Bridges.

Masonry Bridges for Railways. Discusses the reason for the recent construction of many masonry bridges for railways. 1200 w. Eng Rec—Feb. 22, 1902. No. 46423.

Reinforcing.

Reinforcing an Undermined Bridge Pier. Describes the method of sinking a new caisson around an old one which was thrown out of plumb by floods. 1300 w. Eng Rec—Feb. 8, 1902. No. 46162.

Saginaw Bridge.

Relative Merits of Swing and Bascule Bridges and the Saginaw Bridge Letting. Letters from Albert H. Scherzer and Edgar A. Rossiter. The first letter discusses the advantages of the bascule bridge; the second explains why it is not desirable or required at Saginaw. 2400 w. Eng News—Feb. 13, 1902. No. 46196.

Street Bridges.

A Report on the Condition of Street Bridges in Indianapolis. Report of T. L. Condron, showing the dangerous condition of four old bridges over the White River, three of which are carrying electric railway cars, although never designed for such loading. 1300 w. Eng News—Feb. 20, 1902. No. 46496.

Tennessee Bridge.

An Eventful Bridge History. Hunter M'Donald. Read at meeting of the Engng. Assn. of the South. History of the bridge of the Nashville, Chattanooga & St. Louis Railway over the Tennessee River at Johnsonville, Tenn. The bridge was subject to an unusual number of disasters. 2300 w. R R Gaz—Feb. 7, 1902. No. 46112.

Testing.

The Testing of Railway Bridges. Discusses the need of the first and of periodic tests, giving the opinions of various engineers and the methods used. 3300 w. Engr, Lond—Feb. 14, 1902. No. 46461 A.

Timber.

The Kintai Wooden Bridge. Illustrated description of a wooden arch bridge with three 150-ft spans and two somewhat shorter, built in Japan in 1673. 700 w. Eng Rec—Feb. 8, 1902. No. 46161.

Viaduct.

Arched Viaduct Over the Seine, Paris. Two-page plate and other illustrations, with description of interesting features. 1700 w. Engng—Jan. 31, 1902. No. 46129 A.

Summer Street Viaduct, South Boston. Herman K. Higgins. A statement of the complicated conditions to be met with; an illustrated description of the structure and its construction. 3800 w. Jour Assn of Engng Soc's—Dec., 1901. No. 45931 C.

CANALS, RIVERS AND HARBORS.

Dock Equipment.

See Electrical Engineering, Power Applications.

Drainage.

Drainage Improvement by Dredging. E. E. Watts. Abstract of a paper read before the Indiana Engng Soc. Discusses drainage improvement works, methods and cost. 2500 w. Eng News—Feb. 13, 1902. No. 46198.

Land Improvement in Italy (Bodenmeliorationen in Italien). Adolf Friedrich. A well illustrated account of several great drainage and land reclamation enterprises and some irrigation work, visited by a party of students from Vienna. 2 plates. 1200 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 18, 1902. No. 46354 B.

We supply copies of these articles. See page 159.

Dredges.

United States Dredger "Florida." Illustrated description of an interesting shallow draught dredger and snag-boat for government use in improving the channels of small rivers. 1200 w. Engr, Lond —Jan. 24, 1902. No. 45990 A.

Great Canals.

Great Canals of the World. Information from a study prepared by the Treasury Bureau of Statistics, for publication in the *Monthly Summary of Commerce and Finance*, showing the commerce, cost, and dimensions of the great canals of the world. 1200 w. Am Archt—Feb. 8, 1902. No. 46126.

Inclined Planes.

New Plans for the Lifts on the Danube-Moldau Canal (Neue Entwürfe für die Hebewerke des Donau-Moldaucanals). Victor Schönbach. A very well illustrated description of the proposed inclined-plane canal-boat railways, with map and profile of canal betwen Vienna and Budweiss, Bohemia. 6 plates. 4500 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 4, 1902. No. 46348 B.

Isthmian Canal.

Panama or Nicaragua? Editorial discussion of the present position of this project, presenting the leading features of the two schemes. 1800 w. Engng—Jan. 24, 1902. No. 45982 A.

The Isthmian Canal. George S. Morison. Extracts from an address at a banquet of the Chicago Commercial Club. Gives brief descriptions of the Panama and Nicaragua routes, stating the advantages of each, and giving reasons why the Panama Canal is to be preferred. 5000 w. R R Gaz—Feb. 7, 1902. No. 46113.

The Latest Route Proposed for the Isthmian Canal—Mandingo Route. The statement of the American Isthmus Ship Canal Company concerning this proposed route, with map. 2500 w. Nat Geog Mag —Feb., 1902. No. 45964 C.

Time as it Affects the Selection of an Isthmian Canal Route. A letter from H. H. Trundle discussing various matters relating to proposed routes. Also additional notes. 2800 w. Eng News—Feb. 20, 1902. No. 46493.

Why Not Own the Panama Isthmus? Frederic C. Penfield. Discusses the canal routes, favoring Panama, and suggesting the purchase of the territory. 2500 w. N Am Rev—Feb., 1902. No. 45922 D.

Work of the Isthmian Canal Engineers. Frederick Moore. An outline of the work done in surveying routes and gathering the needed information to determine the most advantageous location. Sci Am—Feb. 1, 1902. No. 45959.

Philadelphia.

Development of the Delaware River Water Front of Philadelphia, Including Description of Bulkhead, Street, and Pier Construction. George S. Webster. An illustrated article giving early history and description. 10,000 w. Pro Engrs' Club of Phila—Jan., 1902. No. 46040 D.

Prague.

Progress in the Raft Harbor Works near Prague (Baufortschritt beim Flosshafenbaue auf der Kaiserwiese oberhalb Prag im Jahre 1901). M. Machulka. A brief illustrated account of harbor works, including a bridge, on the Moldau above Prague, Bohemia. 600 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 11, 1902. No. 46352 B.

Sault Ste. Marie.

The Enlargement of the Sault Canal. Waldon Fawcett. An illustrated article on the proposal to enlarge the locks of the governmental ship canal which connects Lakes Huron and Superior. 1500 w. Am Mfr—Feb. 20, 1902. No. 46470.

Ship Canal.

The Proposed Taunton River and Boston Harbor Ship Canal. From the report of Frank W. Hodgson. An abstract of the surveys and estimates for a proposed ship canal to connect Narragansett Bay and Boston Harbor, by the way of the Taunton and Weymouth Fore Rivers. 900 w. Eng News—Feb. 6, 1902. No. 46110.

Tide Indicator.

See Electrical Engineering, Power Applications.

Vienna.

The Regulation of the Danube at Vienna (Ueber Donau-Regulierungs-Bauten bei Wien). Rudolf Halter. A general account of the river improvement and harbor work which has been carried on for many years. Plans. 6500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 31, 1902. No. 46360 B.

CONSTRUCTION.

Dams.

British Practice in the Building of Earth Dams. Letter from E. Sherman Gould on the relative merits of masonry and puddle for core walls, and one from C. F. Marsh, with illustration, on the construction of an earth dam over 100 ft. high. 1000 w. Eng Rec—Feb. 8, 1902. No. 46172.

Concerning the Design of Earth Dams and Reservoir Embankments. Editorial discussion of various constructions, presenting one that is especially recommended for security and tightness as well as cheapness. 2500 w. Eng News—Feb. 20, 1902. No. 46492.

• *We supply copies of these articles. See page 159.*

Remarks on the Recent Failures of Masonry Dams in the South. B. H. Haraway. Discusses the designs used, and the causes of failure. Ill. 1800 w. Eng News—Feb. 6, 1902. No. 46105.

The Design of American Dams. A discussion of the value of masonry as a material for core walls. 1100 w. Eng Rec—Feb. 15, 1902. No. 46254.

The High Earth Dam Forming Druid Lake, Baltimore Water-Works, Alfred M. Quick. An illustrated description of this dam, supposed to be the highest earth dam in the world, and the unusual plan followed in its construction. 1500 w. Eng News—Feb. 20, 1902. No. 46495.

The Limiting Height of Earth Dams. A letter from E. Sherman Gould, assuming 70 ft. as the maximum height yet attained, and discussing causes of destruction, construction, &c. 1600 w. Eng News—Feb. 20, 1902. No. 46494.

Fireproofing.

A New Method of Testing Fire-Resisting Qualities of Fireproofed Wood. Ira H. Woolson. Deals with the results obtained in a long series of experimental tests, describing methods and discussing other qualities that must be considered in the use of fireproofed wood. 4200 w. Eng News—Feb. 20, 1902. No. 46490.

Fire and Water Test of Vulcanite Fireproof Floor, Philadelphia, Pa. Illustrates the floor and test house, and gives the conditions and results of the tests. 1200 w. Eng News—Feb. 6, 1902. No. 46107.

Resistance to Fire of Floors and Doors. Edwin O. Sachs. From a paper read before the School of Military Engineering, England. A report of experimental tests, describing the construction, method of testing and effect. 4500 w. Arch't, Lond—Jan. 31, 1902. No. 46118 A.

Tests of Fire-proof Partitions by the New York City Building Department. Brief report of interesting series of tests of the effect of fire and water on various forms of partitions. 2200 w. Br Build—Jan., 1902. No. 45924 D.

Piles.

The Supporting Power of Piles. Letters by E. P. Goodrich and C. Baillairge discussing the supporting power of a pile and its carrying power considered as a column. 1500 w. Eng Rec—Feb. 22, 1902. No. 46433.

Prison Construction.

Cell Construction in the Tombs Prison, New York. Illustrated description of the steel work of the cells recently installed in the municipal prison. 1900 w. Eng Rec—Feb. 15, 1902. No. 46262.

Roads.

Civilization and Wagon Roads. Ira O. Baker. Read before the Illinois Soc. of Engrs. & Surv's. On the merits of dirt roads. 1900 w. Eng Rec—Feb. 15, 1902. No. 46257.

Oil in Street Construction. T. F. White. Abstract of a paper read before the League of California Municipalities. Describes the practice during the last three years in San Bernardino County, Cal., in making roads of loose sand and sandy clay as well as better material, by soaking them with oil. 2600 w. Eng Rec—Feb. 22, 1902. No. 46424.

Roads and Transport Systems in Madagascar. A sketch of the railway in progress of construction, and explanation of the nature of work. Also account of the macadamized road, and discussion of the system of vehicular traffic to be used on it. 1500 w. U S Cons Repts, No. 1276—Feb. 27, 1902. No. 46479 D.

The Settlement of Lorraine Street, Hartford, Conn. Frederick L. Ford. Illustrated description of a big landslide and the method of checking it. 1300 w. Eng Rec—Feb. 22, 1902. No. 46425.

Structural Work.

Architectural and Constructional Engineering. T. C. Cunnington. Read before the British Archt. Assn. Describes a series of steel frame structures recently erected. Deals first with American tall structures, then with roofs executed to fill special requirements. 2000 w. Arch't, Lond—Jan. 14, 1902. No. 46117 A.

Earthquake-Proof Buildings in Japan. Illustrated description of methods of construction adapted to divide up brick walls in small sections firmly held by steelwork. 1400 w. Eng Rec—Feb. 22, 1902. No. 46431.

Some Features of the Design and Construction of High Buildings. William Copeland Furber. Outlines the courses that led to this peculiar type of building, and discusses the design and construction, giving illustrations. Considers fireproofing, rust protection, wind bracing, &c., &c. 10,700 w. Pro Engrs' Club of Phila—Jan., 1902. No. 46036 D.

Structural Steel Details of a Two-Story Boiler House. Illustrates and describes details of the new 16,000 h. p. boiler house of the United Railways and Electric Co. of Baltimore. 2500 w. Eng Rec—Feb. 1, 1902. No. 46071.

Steelwork in the Prudential Building, Newark. Illustrated detailed description of an interesting building. 1800 w. Eng Rec—Feb. 1, 1902. No. 46072.

Subway.

Mining Methods in the New York Subway. D. H. Newland. An illustrated article giving an account of the methods of construction, the materials, mechanical devices used, &c. 3500 w. Eng & Min Jour—Feb. 1, 1902. No. 46043.

We supply copies of these articles. See page 159.

Tunnel Explosion.

Explosion of Dynamite at the Rapid Transit Subway. An illustrated account of the disaster in New York at the corner of Park Avenue and Forty-first street. 900 w. Sci Am—Feb. 8, 1902. No. 46087.

The Dynamite Explosion on the New York Rapid Transit Subway. An account of the accident in New York city on Jan. 27, which caused loss of life and great destruction of property. 1300 w. Eng News—Jan. 30, 1902. No. 45915.

The Effect of a Surface Explosion of Dynamite. Illustrates and describes the surface effect of the explosion at 41st street and Park Avenue. 2200 w. Eng Rec—Feb. 1, 1902. No. 46070.

Wrecked by Dynamite. Brief account of the terrible explosion in New York rapid transit tunnel, which caused loss of life, many serious injuries, and a destruction of a million dollars worth of property. Ill. 1000 w. Fire & Water—Feb. 1, 1902. No. 45968.

Tunnels.

Driving Tunnels by Hand. J. H. Shockley. Some points of value from an experience of over twenty years throughout North America. 1000 w. Min & Sci Pr—Feb. 1, 1902. No. 46050.

The Pennsylvania Railroad Tunnel Bridge. Longitudinal view and cross section of proposed construction with notes. 600 w. Sci Am—Feb. 1, 1902. No. 45958.

MATERIALS.

Cement.

Tests and Constitution of Portland Cement. A. D. Elbers. A discussion of the tests adopted by engineering societies, with suggestions helpful in the study of causes of deterioration of current work. 3300 w. Am Mfr—Jan. 30, 1902. No. 45935.

The History, Manufacture, Testing, and Uses of Portland Cement. H. Howard Humphreys. Reviews the history, principal methods of manufacture, and of testing, in the present article. 4000 w. Quarry—Feb. 1, 1902. Serial. 1st part. No. 46212 A.

Cement Works.

The Cement Works of I. C. Johnson and Co., Ltd., Greenhithe. Plan and description of these works and their equipment, and some of the methods employed. Ill. 4000 w. Engr, Lond—Feb. 7, 1902. No. 46239 A.

The Rudelsburg Portland Cement Works (Die Portlandzementfabrik Rudelsburg). An illustrated description of the works of the Saxon-Thuringian Company, near Kösen, particularly of the dust-prevention apparatus. 1 plate. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 25, 1902. No. 46310 D.

Concrete.

Concrete Structures for Railways. W. A. Rogers. Abstract of a paper presented to the Illinois Soc. of Engrs. & Surv's. Review of current practice on United States railways in building culverts, abutments and short bridges of concrete. 1700 w. Eng Rec—Feb. 8, 1902. No. 46163.

Reinforced Concrete.

Development of Reinforced Concrete Construction from the Beginning to the Present (Entwicklung des Betoneisenbaues vom Beginn bis zur Gegenwart). J. A. Spitzer. An illustrated general review of the subject, with a particular account of some experiments made at Vienna in 1898. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 31, 1902. No. 46359 B.

Tiles.

The Architect's Use of Enamelled Tiles. Halsey Ricardo. Considers their use on hygienic grounds, for saving or reflecting light, and for decoration. Also reviews the history of their use in early times, giving interesting information. Also discussion. 9000 w. Jour Soc of Arts—Jan. 24, 1902. No. 45978 A.

Timber.

Southern Timber Resources. B. E. Fernow. Information concerning the supplies and suggestions for their management. 2800 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46417.

MEASUREMENT.

Surveying.

Directions for Topographical Work in Mountains (Neue Anweisung für Vermessungen im Hochgebirge). Some Swiss regulations for trigonometrical and tachymetrical surveying. 1000 w. Schweiz Bauzeitung—Jan. 4, 1902. No. 46375 B.

Surveyor's Chains.

Standardization of Surveyor's Chains. Henry Louis. Abstract of a paper and discussion before the N. of Eng. Inst. of Min. & Mech. Engrs. Calls attention to the precautions that should be observed in setting out a standard length, and details those employed by the writer. 1800 w. Col Guard—Feb. 14, 1902. No. 46452 A.

MUNICIPAL.

Asphalt Paving.

Criticisms of the New York Asphalt Pavement Specifications. A. W. Dow. Discusses the proposed new specifications submitted by the Engineer of the Commissioners of Accounts. 5500 w. Eng News—Feb. 6, 1902. No. 46111.

Proposed Changes in the New York Asphalt Paving Specifications. Report of Otto H. Klein submitted to the mayor of New York by the Commissioners of Ac-

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counts. It is mainly a comparison of the old and proposed new specifications. 6000 w. Eng News—Feb. 6, 1902. No. 46109.

Pavements.

Roads, Streets and Pavements. H. G. Tyrrell. Gives points on the location of roads, and discusses their construction in the present article. 2500 w. Can Engr—Feb., 1902. Serial. 1st part. No. 45973.

The Wooden Pavements of Paris. Letters from Major F. A. Mahan and F. A. Kummer on the traffic and the durability of such pavement. 2000 w. Eng Rec—Feb. 8, 1902. No. 46173.

Refuse Disposal.

See Electrical Engineering, Generating Stations.

Sewage Disposal.

A Sewage-Disposal System for a Country House. William C. Tucker. Illustrates and describes a sub-surface disposal-system for a house with three bathrooms and about twenty-one fixtures. 700 w. Am Arch't—Feb. 22, 1902. No. 46469.

Sewerage and Sewage Disposal at the Paris Exposition (Canalisationswesen und Abwasserreinigung auf der Pariser Weltausstellung 1900). Josef Ruiss. A general review of the exhibits of the various countries, with a well illustrated and comprehensive description of the Paris sewerage works. Serial. 2 parts. 16000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 10, 17, 1902. No. 46357 each B.

The Purification of Sewage by Septic Tanks and Various Supplemental Processes. W. S. Shields. A paper, slightly condensed, read before the Illinois Soc of Engrs. & Surveyors. Gives experience with plants at Wauwatosa, Wis., and Lake Foust, Ill., with general remarks. 1800 w. Eng News—Jan. 30, 1902. No. 45917.

The Purification of Sewage. W. S. Shields. Slightly condensed from a paper read before the Illinois Soc. of Engrs. & Surv's. Describes the principles involved in the design of a number of American septic disposal systems. 2200 w. Eng Rec—Feb. 8, 1902. No. 46168.

The Septic Tank System at Fond du Lac. Describes a plant in which sewage is pumped by electric motors, stopped and started automatically, to a septic tank, the effluent of which is discharged either to filter beds or directly into a stream. 800 w. Eng Rec—Feb. 22, 1902. No. 46428.

The Sewage Disposal of Suburban Houses and Public Institutions. Dr. P. H. Bryce. Read at meeting of the Ontario Assn. of Archt's. Indicates an efficient and economical method of dealing with all house wastes. 3500 w. Can Archt—Feb., 1902. No. 46411 C.

Sewers.

Cleaning an Altoona Sewer. Illustrated description of the method employed on about a mile of 30-in. pipe sewer and 44 x 33-in. brick sewer. 900 w. Eng Rec—Feb. 8, 1902. No. 46164.

Concrete Sewer Construction at Coldwater, Mich. Harry V. Gifford. Illustrated description of the methods used, and a report of tests of materials and other information. 2400 w. Eng News—Jan. 30, 1902. No. 45918.

Making Sewer Connections. Discusses the connecting of house drains, intercepting traps, air inlets, &c. Ill. 2500 w. Met Work—Feb. 1, 1902. No. 45923.

The Design of Sewers (Beitrag zur Berechnung von Kanalisationscitungen). Hr. Hecker. Graphical and other methods for calculating sewer systems adequate for any possible rainfall. Tables. Serial. 2 parts. 3 plates. 4000 w. Gesundheits Ing—Dec. 15, 31, 1901. No. 45897 each B.

The Early History of the Memphis Sewers. Extracts from a paper by A. T. Bell, describing the separate sewers built between 1880 and 1897, which first established in the United States the correct principles to follow in designing such work. Also editorial comment. 3300 w. Eng Rec—Feb. 15, 1902. No. 46258.

The Sewerage Systems of Sydney, N. S. W. Brief description of the various compressed air, electric, and steam pumping plants, mechanical and biological sewage treatment works, and other features of the sewerage systems employed. 1600 w. Eng Rec—Feb. 15, 1902. No. 46261.

WATER SUPPLY.

Driven Wells.

A Driven Well Gravity Water Supply. Describes an unusual well system installed as a supply for mills and tenements in Massachusetts. Ill. 1100 w. Eng Rec—Feb. 1, 1902. No. 46069.

Drought.

The Autumns's Drought. An Account of the drought in England during the autumn of last year, and its effect on the water supply. 4000 w. Engr, Lond—Feb. 7, 1902. No. 46240 A.

Filtration.

The Puech Graded Gravel Filters (Les Filtres Degrossiseurs Puech). Hippolyte Fontaine. A short, illustrated account of this filtration system, in which the water flows successively through three beds of gravel, the coarsest first. 1500 w. Bull Soc d'Encouragement—Jan., 1902. No. 46389 G.

Settling Basins and Slow Sand Filter Beds for Pittsburg, Pa. An illustrated description of the plan and details of the work proposed. The chief objects are to remove turbidity and bacteria. 2800 w. Eng News—Feb. 13, 1902. No. 46197.

We supply copies of these articles. See page 159.

Ground Water.

A New Method of Determining the Velocity of Underground Water. Charles S. Slichter. Describes an electrical method which has given satisfactory results with rapidity. Ill. 900 w. Eng News—Feb. 20, 1902. No. 46491.

Ground Water Supplies and the Oyster Industry. Text of a decision of the N. Y. Supreme Court in a suit to prevent the operation of a ground water pumping station because it diminished the fresh water at the mouth of a creek where oysters are fattened. 1100 w. Eng Rec—Feb. 22, 1902. No. 46430.

Hamilton, Ohio.

Contamination of the Water Supply of the City of Hamilton, Ohio. John Lorenz. Gives briefly the history of this city's supply, and the plan adopted for remedying the latest trouble. 1200 w. Munic Engng—Feb., 1902. No. 46034 C.

Inaugural Address.

Mr. Percy Griffith on Water Supply. Extract from the inaugural address at the Society of Engineers, touching on the lines of advancement for the present and future. 5000 w. Jour Gas Lgt—Feb. 11, 1902. No. 46437 A.

London.

London Water Supply. Editorial discussion of the present outlook for the settlement of the Metropolitan water question, by the establishment of a water board. 3300 w. Engng—Feb. 7, 1902. No. 46233 A.

The Purchase of the London Water Companies' Works. An outline of the Local Government Board's project for purchasing and managing the works of the companies supplying London and the vicinity with water. 1000 w. Eng Rec—Feb. 22, 1902. No. 46429.

North Sea Islands.

The Water Supply of Some North Sea Bathing Resorts (Die Wasserversorgung einiger Nordseebäder). Hr. Herzberg. A paper before the "Deutscher Verein von Gas und Wasserfachmännern," giving an account of borings and ground-water conditions on the East Frisian Islands, with discussion. 4000 w. Gesundheits Ing—Nov. 30, 1901. No. 45878 B.

Reservoirs.

Further Reports on the Jerome Park Reservoir. Letters from Mr. Elnathan Sweet, and Mr. J. J. R. Croes, with responses by Mr. Wm. R. Hill. 5700 w. Eng News—Feb. 6, 1902. No. 46108.

Government Construction of Reservoirs in Arid Regions. H. M. Chittenden. A statement of the reservoir problem of the arid section of the United States, showing its importance, and discussing the question in its various aspects. 6000 w. N Am Rev—Feb., 1902. No. 45921 D.

Riparian Rights.

Interstate Riparian Water Rights. Full text of decision of United States Circuit Court of Appeals in Pine v. Mayor of New York. This decision practically forbids any corporation or individual of one state to interfere in any manner with the free flow of water in a stream entering another state. Also editorial. 4600 w. Eng Rec—Feb. 8, 1902. No. 46169.

Turbidity.

Method of Calibrating Turbidimeters. George C. Whipple and Daniel D. Jackson. Illustrates the essential parts of the instrument explaining its use and the method of calibrating. 1500 w. Tech Quar—Dec., 1901. No. 46008 E.

Waste.

Water Cost and Water Waste. A. L. Holmes. Abstract of a paper read before the Mich. Engng. Soc. at Grand Rapids. Reports concerning the supply of several important cities, and favors the metering of water systems. 2300 w. Eng News—Feb. 6, 1902. No. 46106.

Water Waste in Cleveland. Describes experiments proving the large waste of water in Cleveland and the efficacy of meters in preventing it. 700 w. Eng Rec—Feb. 22, 1902. No. 46426.

Water Bill.

The London Water Bill. Abstract of the Government Bill in connection with the water supply, with editorial comment. Proposes to establish a Water Board of sixty-seven members with a chairman and vice-chairman. 4500 w. Engr, Lond—Feb. 7, 1902. No. 46241 A.

Water Works.

America's First Water Works. From the *Bethlehem Times*. Brief description of an arrangement for suplying a small community with water, which was put in operation in 1754. 1300 w. Dom Engng—Feb. 15, 1902. No. 46466 C.

Some Economic Features of Municipal Engineering. C. S. Burns. Mainly devoted to an explanation of the great possibilities in the way of economy that can be secured by attention to small details of water-works design. 2900 w. Eng Rec—Feb. 8, 1902. No. 46166.

MISCELLANY.

Temperature.

The Temperature of Germany in Its Relation to Artificial Heating (Die Temperaturverhältnisse Deutschlands, soweit sie für die Beheizung der Räume in Betracht Kommen). Hr. Marx. A paper before the Heating and Ventilating Engineers on the climate, and particularly the temperature of Germany, with tables and diagrams. 3000 w. Gesundheits Ing—Jan. 15, 1902. No. 45882 B.

We supply copies of these articles. See page 159.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Repairing.

A New Telegraph Steamer, SS. "Viking." Description of latest cable laying and repairing steamer, and its equipment. Ill. 1800 w. Elec Rev, Lond—Jan. 31, 1902. No. 46246 A.

Cables.

Telephone Cables—Their Construction and Maintenance. P. Kerr Higgins. An illustrated article stating the conditions as they exist at the present time. 3000 w. Am Tel Jour—Feb. 1, 1902. Serial. 1st part. No. 46024.

The German-American Cable. From the *Elektrotechnische Zeitschrift.* An interesting account of the new Emden-Fayal-New York cable which was laid over a year ago. 3500 w. Elect'n, Lond—Feb. 14, 1902. No. 46445 A.

The Manufacture of Submarine Cables. The new cable-works of Siemens and Halske are illustrated and the process of manufacture is described. 1400 w. Sci Am—Feb. 8, 1902. No. 46086.

Development.

The Development of Electrical Science. From an address by Henry A. Gray, at a meeting of the Engineer's Club of Toronto. Traces the development of telegraphy, telephony, and electric lighting. 3000 w. Can Elec News—Feb., 1902. No. 46187.

Exchange.

The National Telephone Co.'s New Battersea Exchange. Illustrated description of an exchange with a lamp-signal switch board, working on the Kellogg central battery system. 2000 w. Elect'n, Lond—Feb. 7, 1902. Serial. 1st part. No. 46219 A.

Farm Lines.

Farm Telephone Lines in Northern Ohio. A. E. Dobbs. Gives briefly the history of lines in Geauga County. Ill. 3500 w. Am Tel Jour—Feb. 15, 1902. No. 46273.

Space Telegraphy.

How to Construct an Efficient Wireless Telegraph Apparatus at a Small Cost. A. Frederick Collins. Illustrated description. 1500 w. Sci Am Sup—Feb. 15, 1902. No. 46207.

Induction Wireless Telegraphy. V. H. Emerson. A brief account of this system as operated on the Lehigh Valley and other railroads. 1000 w. Elec Wld & Engr—Feb. 15, 1902. No. 46292.

Marconi's Achievement. Remarks on his recent success in signalling from Cornwall, England, to Newfoundland. 1200 w. Mach, N. Y—Feb., 1902. No. 46078.

Some Wireless Telegraph Stations of the Allgemeine Elektricitäts Gesellschaft (Einige Funkentelegraphische Installationen der Allgemeinen Elektricitäts Gesellschaft). Graf Arco. An illustrated description of wireless telegraph installations on the Slaby-Arco system on board the "Deutschland," at Cuxhaven, and on a lightship and at a lighthouse near Esbjerg, Denmark. 1000 w. Elektrotech Zeitschr—Jan. 30, 1902. No. 46327 B.

The Actual State of Wireless Telegraphy with Hertzian Waves (Sur l'Etat Actuel de la Télégraphie sans Fil par Ondes Hertziennes). Capt. Ferrié. An illustrated paper giving a good general review of the whole subject. 1100 w. Bull Soc Internationale d'Electriciens—Jan., 1902. No. 46397 E.

The Marconi School of Wireless Telegraphy. H. J. Shepstone. Illustrated account of a school opened at Frinton-on-Sea, in Essex, England, for the teaching of wireless telegraphy. 800 w. Sci Am—Feb. 1, 1902. No. 45960.

Wireless Telegraphy. H. W. Sullivan. Notes on the history, and present and future prospects of the new enterprise as an industry. 1400 w. Elec Rev, Lond—Feb. 14, 1902. No. 46448 A.

Space Telephony.

Wireless Telephony Through the Earth (Téléphonie sans Fil, par la Terre). E. Ducretet. Notes on experiments with the transmitter connected to earth plates and the receiver to a small sphere on the floor of the catacombs. Speech was well reproduced. 400 w. Comptes Rendus—Jan. 13, 1902. No. 46396 D.

Synchronous Telegraphy.

Modern Synchronous Telegraph Systems (Moderne Telegraphen-Systeme mit Synchroner Bewegung). Karl v. Barth. An illustrated description of the Hughes, Baudot, Delany and other systems and apparatus. 1 plate. 5000 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 25, 1902. No. 46355 B.

Telautograph.

The Gruhn Telautograph (Ueber einen Neuen Telautographen der Kopier-Telegraph-Gesellschaft m. b. H., Dresden). Hr. Gruhn. Paper before the Elektrotechnischer Verein giving an illustrated description of an aparatus for transmitting writing and sketches telegraphically. At

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the receiving station a mirror, controlled by the transmitter, throws a beam of light which photographs the record. 4000 w. Elektrotech Zeitschr—Feb. 6, 1902. No. 46332 B.

Telephony.

Electrolysis of Telephone Cables. A. E. Dobbs. Discusses the trouble in connection with underground cables, and the methods of preventing. Ill. 2000 w. Am Tel Jour—Feb. 8, 1902. No. 46140.

Multiple Switchboards. A. E. Dobbs. Describes only the drop or target type, and shows the advantage of multiple switchboard to operators of seven small exchanges. 1600 w. Am Tel Jour—Feb. 22, 1902. No. 46412.

Telephony in Great Britain. Gives brief descriptions of the three competitive systems which have been put into operation, explaining the attitude of the government. Ill. 2800 w. Elec Rev, N. Y—Feb. 15, 1902. No. 46284.

Telephony Twenty Years Ago and Today. Thomas D. Lockwood. A brief review of the general advancement made. 1600 w. Elec Rev, N. Y—Feb. 15, 1902. No. 46288.

The Common Battery System. J. J. Carty. An address before the New York Elec. Soc. Reviews the recent important advances made in telephony, and outlines the main features of the system named. 2400 w. Elec Rev, N. Y—Feb. 22, 1902. No. 46468.

Transmitter.

A New Loud Speaking Microtelephone (Un Nouveau Microtélephone Haut Parleur.) From a paper by W. Krejsa before the Vienna Electro-Technical Society. An illustrated description of a transmitting apparatus in which the indication coil has an armature whose distance from the core varies with the current. 400 w. Electricien—Sept. 28, 1901. No. 45847 B.

DISTRIBUTION.

Conduits.

Separate Conduits for High and Low Potential Wires. William Brophy. Abstract of a paper read before the International Assn. of Munic. Electr'ns. An account of the causes that led to placing all electric wires underground, and the systems of distribution in use. Considers also the losses due to the joint occupancy of conduits. 5200 w. Am Tel Jour—Feb. 22, 1902. Serial. 1st part. No. 46413.

Controller.

Simplified Polyphase Current Controller (Ueber Vereinfachte Drehstromkontroller). Eugen Klein. An illustrated description of a form of controller in which the number of contact pieces and connections is greatly reduced. 800 w. Elektrotech Zeitschr—Jan. 23, 1902. No. 46322 B.

Distributing Mains.

Practical Notes on Continuous-Current Distributing Mains. John C. A. Ward. Abstract of a paper read before the Glasgow Soc. of the Inst. of Elec. Engrs. Presents some of the causes that effect the efficiency of distribution, and gives a comparison of the different systems. Ill. 2500 w. Elect'n, Lond—Jan. 24, 1902. Serial. 1st part. No. 46000 A.

Earth Currents.

Earth Currents Derived from Distributing Systems. E. Basil Wedmore. Read before the Inst. of Elec. Engrs., England. A statement of some of the conclusions reached, with their application. 3500 w. Elect'n, Lond—Jan. 24, 1902. Serial. 1st part. No. 45999 A.

The Leakage of Current from Buried Bare Conductors. Reviews the paper by E. Basil Wedmore before the Inst. of Elec Engrs and its discussion. Ill. 1400 w. Elec Rev, Lond—Feb. 14, 1902. No. 46447 A.

Electricity Supply.

Some Notes on the Influence of the Sub-Station Equipment and Transmission Line on the Cost of Electricity Supply. Andrew Stewart. Read before the Newcastle section of the Inst. of Elec. Engrs. Discusses the distribution system under present conditions, and some points in the equipment of sub-stations. 2400 w. Elec Engr, Lond—Jan. 31, 1902. Serial. 1st part. No. 46125 A.

Single-Phase.

Single-Phase Transmission Plant with Power Distribution. Illustrated detailed description of the water-power plant at La Goule. 1200 w. Am Elect'n—Feb., 1902. No. 46026.

Transformer Switches.

The Economy of Automatic Transformer Switches (Ueber die Oekonomie von Hochspannungsfernschaltern). E. H. Geist. A discussion, showing that only in exceptional cases is it economical to instal switches which automatically cut out the primary winding of a transformer when there is no load on the secondary. 1200 w. Elektrotech Zeitschr—Jan. 16, 1902. No. 46319 B.

ELECTRO-CHEMISTRY.

Accumulators.

Accumulator Cells with Carriers of Light Non-Conducting Materials. A description of a secondary cell, the invention of A. Ricks. 1400 w. Elect'n, Lond—Feb. 14, 1902. No. 46444 A.

The Construction of a Small Storage

Cell. H. F. Shepherd. Sketches and description of a cell which has given excellent results. 800 w. Am Elect'n—Feb., 1902. No. 46029.

The Influence of Temperature on the Capacity of Lead Accumulators (Ueber den Einfluss der Temperatur auf die Kapacität der Bleiakkumulatoren). Ch. Liagre. From *L'Eclairage Electrique*. A record of experiments with a d'Arsonval-Vaugeois cell, with positive and negative Planté plates, showing that the capacity increases with the temperature. Diagram. 600 w. Elektrotech Zeitschr—Jan. 16, 1902. No. 46320 B.

The Leitner Accumulators for Electromobile and Traction Work. Illustrated article giving information concerning storage batteries for automobile and traction use, for central station work, and for train and yacht lighting. 2000 w. Elec Times—Feb. 6, 1902. No. 46208 A.

Welsbach's Carbon-Zinc-Cerium Salt Accumulator. Brief description. 1600 w. Horseless Age—Feb. 12, 1902. No. 46183.

Alkalies.

The "Bell" Gravity Process for the Electrolytic Production of Alkalies and Chlorine. John B. C. Kershaw. A description of the "Bell" cell and estimates of costs. 1100 w. Elect'n, Lond—Feb. 7, 1902. No. 46223 A.

Aluminum.

The Electrolytic Production of Aluminum (Versuche über Aluminiumdarstellung). F. Haber and R. Geipert. An illustrated account of elaborate laboratory experiments to determine the processes in general use with scientific exactness. 2 parts. 7000 w. Zeitschr f Elektrochemie—Jan. 2, 9, 1902. No. 45863 each G.

Carbon Bisulphide.

The Electrical Manufacture of Carbon Bisulphide. Edward R. Taylor. Gives illustrations of the furnace, with description. 1000 w. Elec Rev, N. Y—Feb. 1, 1902. No. 45944.

Review.

Electro-Chemistry in 1901 (Die Elektrochemie im Jahre 1901). Dr. M. Krüger. A general review. The present number is devoted to theoretical investigations and publications. Serial. 1st part. 2000 w. Elektrochemische Zeitschr—Jan., 1902. No. 45868 G.

Storage Batteries.

See Electrical Engineering Generating Stations.

ELECTRO-PHYSICS.

Atomic Theory.

Recent Developments of the Atomic Theory and Its Connection with Light and Electricity. C. C. Garrard. Gives, in the present article, a summary of recent investigations and discoveries which show that long accepted theories must be revised. 1600 w. Elec Rev, Lond—Feb. 7, 1902. Serial. 1st part. No. 46217 A.

Discharges.

Rotary Disks. Alfred G. Dell. A report of experimental investigations of electrical discharges in a spark gap beneath a rotating mica disk. 1800 w. Elec Wld & Engr—Feb. 15, 1902. No. 46293.

Electrical Phenomena.

Celestial Explosions and Their Relations to Electrical Phenomena. Hudson Maxim. Explains what an explosion really is, and considers some celestial explosions. Ill. 4700 w. Elec Age—Jan., 1902. No. 46020 C.

Electrodynamics.

General Equations of Electrodynamics in Conductors and Perfect Dielectrics at Rest (Equations Générales de l' Electrodynamique dans les Conducteurs et les Diélectriques Parfaits en Repos). E. Carvallo. A generalisation of Kirchhoff's two laws, with interpretation, application and comparison with Maxwell's results. 800 w. Comptes Rendus—Jan. 6, 1902. No. 46393 D.

Electrostatic Field.

The Electrostatic Field about an Electric Current and the Theory of Professor Poynting (Sur le Champ Electrostatique autour d'un Courant Electrique et sur la Théorie du Professeur Poynting). W. de Nicolaiève. A description and record of experiments. 600 w. Comptes Rendus—Jan. 6, 1902. No. 46392 D.

Hysteresis.

Rotary Hysteresis (Ueber Rotirende Hysteresis). A. Dina. An experimental comparison between rotary, static and alternating current hysteresis, with curves and tables. 4000 w. Elektrotech Zeitschr—Jan. 16, 1902. No. 46316 B.

Interrupter.

A New Mercury Interrupter (Ein Neuer Quecksilverstrahl-Unterbrecher). An illustrated description of a current interrupter to be used in connection with induction coils for Röntgen ray work, in which a stream of mercury is broken at intervals in a liquid insulating material. 1000 w. Elektrotech Zeitschr—Feb. 6, 1902. No. 46331 B.

Magnetic Deflection.

Magnetic Deflection of Long Steel-Wire Plumb-Lines. Dr. William Hallock. A report of experiments made and evidence found, which support the conclusion that iron or steel wire ought not to be used for plumb-lines where accuracy is needed. 700 w. Elec Wld & Engr—Feb. 8, 1902. No. 46157.

Magnetic Properties.

The Relation between the Magnetic

Properties and the Electrical Conductivity of Magnetic Materials (Ueber das Verhältniss der Magnetischen Eigenschaften zum Elektrischen Leitvermögen Magnetischer Materialien). E. Gumlich. A review of experiments by Barrett, Brown and Hadfield described in the *Scientific Transaction of the Royal Dublin Society*, showing particularly the influence of aluminum and silicon on iron. Tables. 1500 w. Elektrotech Zeitschr—Feb. 6, 1902. No. 46329 B.

Magnetic Saturation.

The Best Degree of Saturation for Polyphase Generators (Günstigster Sättigungsgrad Mehrphasiger Generatoren). Emil Korrodi. The best flux density for the field magnets of polyphase generators is shown graphically. 400 w. Elektrotech Zeitschr—Jan. 16, 1902. No. 46318 B.

Magnets.

Tractive Magnets for Straight and Circular Movements (Hubmagnete für Gerade und Kreislinige Bewegungen). F. R. Dietze. An illustrated description of electromagnets, with variously shaped cores and pole-pieces, for lifting and tractive purposes. 1000 w. Elektrotech Zeitschr—Feb. 13, 1902. No. 46334 B.

Radiography.

On Radio-Active Bodies (Sur les Corps Radioactifs). P. and C. Curie. On the nature of the emission from these bodies and of its duration. 600 w. Comptes Rendus—Jan. 13, 1902. No. 46395 D.

Resonance.

Resonance (Ueber Resonanzerscheinungen). Dr. Gustav Benischke. A paper before the Elektrotechnischer Verein, giving various examples of mechanical and electrical resonance, and describing experiments with a small revolving weight which set a table vibrating. 3000 w. Elektrotech Zeitschr—Jan. 30, 1902. No. 46328 B.

Terrestrial Magnetism.

The Absolute Value of the Magnetic Elements on Jan. 1, 1902 (Sur la Valeur Absolue des Eléments Magnétiques au 1er Janvier, 1902). Th. Moureaux. The terrestrial magnetic components, declination, inclination and total force at the observatory of Val-Joyeux near Versailles away from the influence of railway currents. 200 w. Comptes Rendus—Jan. 6, 1902. No. 46394 D.

GENERATING STATIONS.

Alternators.

Alternating Current Machinery for High and Low Frequencies. B. A. Behrend. Illustrated detailed description of generating units in modern use. 1200 w. Elec Rev, N. Y—Feb. 15, 1902. Serial. 1st part. No. 46289.

Alternating Currents.

The Beginning of Alternating-Current Engineering. William Stanley. An interesting account of the introduction and development of the alternating system. Ill. 2500 w. Elec Rev, N. Y—Feb. 15, 1902. No. 46286.

Berlin.

The Berlin Electric Stations in 1902 (Die Berliner Elektricitäts-Werke im Jahre 1902). L. Datterer. A very comprehensive and well illustrated paper. In this part special attention is given to the engines in the Oberspree and Moabit stations. Serial. Part I. 2 plates. 6000 w. Zeitschr d Ver Deutscher Ing—Feb. 8, 1902. No. 46336 D.

Bermondsey.

Bermondsey Combined Refuse Destructor and Electricity Supply Works. Illustrated description of an installation in a suburb of London, said to constitute a part of the most complete and up-to-date municipal undertaking to be found in the United Kingdom. 2400 w. Elec Engr, Lond—Jan. 24, 1902. Serial. 1st part. No. 45994 A.

Bolton.

Electric Generators for the Bolton Corporation. Illustrates and describes the special tests of the two 1100-kilowatt generators, with brief history of the company that built them. 2300 w. Engr, Lond—Jan. 24, 1902. No. 45988 A.

Commutation.

Modern Commutating Dynamo Machinery, with Special Reference to the Commutating Limits. H. M. Hobart. Read before the International Engng. Con., Glasgow, 1901. Views regarding the continuous-current dynamo-electric machine, describing designs. Ill. 3200 w. Engng—Feb. 7, 1902. Serial. 1st part. No. 45237 A.

Electric Supply.

Principles and Profits in Electric Supply. (A Reply to Critics). W. B. Esson. An answer to criticisms, and supplemental to a previous article. 3200 w. Elect'n, Lond—Feb. 7, 1902. No. 46221 A.

The Supply of Electricity in Bulk. Hardman A. Earle. Abstract of a paper read before the Manchester Soc. of the Inst. of Elec. Engrs. Discusses the opposition to electric supply schemes due to the opinion that they are unnecessary and likely to prove financial failures. The present article outlines the general system, and discusses cost. 3500 w. Elect'n, Lond—Feb. 7, 1902. Serial. 1st part. No. 46222 A.

Germany.

Traction, Light and Power Practice in Germany. Abstracts of the discussions of the London section of the Inst. of Elec.

We supply copies of these articles. See page 159.

Engrs. on the works visited and things seen on their recent visit to Germany. The present article is devoted to the subjects in title. 2700 w. Elec, N. Y—Jan. 29, 1902. No. 45902.

"Hunting."

The "Hunting" of Parallel-Coupled Dynamos (Das Pendeln Parallel Geschalteter Maschinen). A. Foppl. A mathematical discussion of the oscillation of electrical energy between dynamos operated in parallel. 5000 w. Elektrotech Zeitschr—Jan. 23, 1902. No. 46321 B.

Isolated Plant.

The Electric Light and Power Plant of the New United States Mint, Philadelphia. Clayton W. Pike. An illustrated detailed description of the electrical equipment. 3300 w. Elec Wld & Engr—Feb. 1, 1902. No. 46011.

The Light and Power Plant of the Mazawattee Tea Company. Illustrates and describes an interesting installation in these new works at New Cross, Eng. 2700 w. Elec Engr, Lond—Jan. 31, 1902. No. 46247 A.

Manhattan Power Stations.

Electrical Machinery in the Power Station and Substations of the Manhattan Ry. Co. Illustrates the more important machines, with brief descriptions. 2000 w. Eng News—Jan. 30, 1902. No. 45910.

Melbourne.

City of Melbourne Electric System. A. J. Arnot. Illustrated detailed description of a comprehensive light and power plant. 2000 w. Aust Min Stand—Dec. 26, 1901. No. 45906 B.

New Zealand.

Electric Power Plant, Rotorna. Oswald Haes. Describes an interesting plant in New Zealand. 3000 w. Aust Min Stand—Dec. 12, 1901. Serial. 1st part. No. 45969 B.

Railway Generator.

1000 K. W. Railway Generator, built by the Union Electric Co., Berlin (1000 K. W. Bahngenerator der Union Elektricitäts-Gesellschaft in Berlin). Dr. Niethammer. An illustrated description of a compound wound, 500 volt, direct current dynamo for the Sheffield (England) tramways. 400 w. Elektrotech Zeitschr—Jan. 16, 1902. No. 46317 B.

Rheostat.

See Electrical Engineering, Measurement.

Rochester, N. Y.

The Central Station of the Citizens' Light and Power Company, Rochester, N. Y. History of this company with illustrated description of the plant and equipment. 7200 w. Elec Rev, N. Y—Feb. 1, 1902. No. 45945.

The New Power Plant of the Citizens' Company of Rochester, N. Y. Illustrated detailed description of a first-class modern electrical station. 6000 w. Elec Wld & Engr—Feb. 1, 1902. No. 46010.

Shawinigan Falls.

The Shawinigan Falls Electrical Development. An illustrated article giving information, particularly relating to the hydraulic portion of the plant. 2500 w. Elec Wld & Engr—Feb. 8, 1902. No. 46156.

Storage Batteries.

Storage Batteries in the Baltimore Belt Line Tunnel Power Plant. An illustrated article describing the battery installed and the service. 900 w. Elec Wld & Engr—Feb. 15, 1902. No. 46291.

Some Results of a Secondary Battery in a Traction Station. States the conditions to be met and the successful results, giving cost. 1100 w. Elec Rev, Lond—Feb. 14. 1902. No. 46446 A.

The Storage Battery in Central Stations. Otto E. Osthoff. Describes some of the details of these installations and discusses their application. 1800 w. Central Station—Feb., 1902. No. 46023.

HEATING AND WELDING.

Electric Furnace.

Electricity in Glass Manufacture. From *Elektrochemische Zeitschrift.* Illustrates and describes the Becker furnace used in experiments at Cologne, discussing the theoretical and practical aspects of the subject. 1700 w. Engr, Lond—Feb. 14. 1902. No. 46463 A.

LIGHTING.

Enclosed Arcs.

The Spectrum of the Enclosed Arc. Dr. Louis Bell. Describes a spectrum accidentally observed. 1200 w. Elec Wld & Engr—Feb. 1, 1902. No. 46009.

Illumination.

The Principles of Illumination. A study in abstract of a paper by D. Burnett, read before the Brooklyn Inst. of Arts and Sciences, indicating the directions in which further improvement in artificial light may take place. 1200 w. Engr, Lond—Jan. 31, 1902. No. 46133 A.

Municipal Plant

An Analysis of the Sixth Detroit Municipal Plant Report. The report of the Detroit Public Lighting Commission. 3500 w. Elec Wld & Engr—Feb. 15, 1902. No. 46295.

Municipal Electric Light Plants. An unfavorable report on municipal plants by a committee of the Worcester, Mass., board of aldermen. 2000 w. Elec Rev, N. Y—Feb. 8, 1902. No. 46159.

We supply copies of these articles. See page 159.

Nernst Lamps.

Practical Value of Nernst Lamps. Alton D. Adams. Discusses to what extent the qualities of the Nernst lamp fit it to displace the arc and incandescent types. 1300 w. Sci Am—Feb 8, 1902. No. 46085.

Night Lamps.

Home-Made Electric Night Lamp. George M. Hopkins. Illustrated description of a simple device for producing a temporary light. 500 w. Sci Am—Feb. 15, 1902. No. 46203.

Review.

Electric Lighting Twenty Years Ago and Since. Prof. Elihu Thomson and Mr. Edwin R. Weeks. Two reviews of interest. 2000 w. Elec Rev, N Y—Feb. 15, 1902. No. 46285.

MEASUREMENT.

Dynamo Testing.

Dynamo-Testing at the English Electric Manufacturing Company's Works, Preston. Comments on the striking features of the works of the English Electric Manufacturing Co., and the tests of two 1100-kilowatt continuous-current machines. Ill. 2800 w. Engng—Jan. 24, 1902. No. 45984 A.

Energy.

Some Important Points in the Commercial Measurement of Electric Energy. Elton J. King. Considers some points in the problem of metering the circuits by the most generally used methods. 4000 w. Engr, U S A—Feb. 1, 1902. No. 46048.

Motor Losses.

The Testing of Motor Losses. W. E. Sumpner. Read before the Birmingham Sec. of the Inst. of Elec Engrs. Suggests three methods of making measurements each of which possesses some advantages. 3000 w. Elect'n, Lond—Feb. 7, 1902. No. 46224 A.

Motor Tests.

Tests of a Compensated Asynchronous Motor. Alexander Heyland. From *Elektrotechnische Zeitschrift*. An account of interesting tests. Those with the compensated motor consisted in determining the position of the brushes giving a minimum phase displacement, and then determining the number of turns of exciting winding just sufficient to prevent all phase displacement. The tests as a generator were the more interesting Ill. 1700 w. Elect'n, Lond—Jan. 24, 1902. No. 45997 A.

Phase.

A New Method of Determining the Shifting of Phase in Alternators with Revolving Pole Rings (Eine Neue Methode zur Bestimmung der Phasenverschiebung an Wechselstrommaschinen mit Rotirendem Polrad). Ottomar Queisser. The poles appear to stand still, when viewed by the light of an arc lamp fed with the alternating current, in a position depending upon the phase angle. 900 w. Elektrotech Zeitschr—Feb. 6, 1902. No. 46330 B.

A New Method of Determining the Angle of Phase Displacement in Alternators with Rotating Pole Rings. O. Queisser. Translated from the *Elektrotechnische Zeitschrift*. Explanation of method. 1100 w. Elec Engr, Lond—Feb. 14, 1902. No. 46443 A.

Rheostat.

Determination of the Number and Amount of the Steps of a Rheostat for the Shunt Windings of Generators (Bestimmung der Stufenzahl und der Einzelnen Stufen für Nebenschlussregler von Generatoren). Rudolf Krause. An illustrated description of a method for designing the resistances for regulating the electromotive force of a dynamo. 1000 w. Elektrotech Zeitschr—Jan. 23, 1902. No. 46323 B.

Improved Plug Rheostats (Neuerung an Stöpselrheostaten). W. Knobloch. An illustrated description of resistance boxes in which one or more metal strips are inserted between those in which are the plug holes, by which arrangement the manipulation is simplified. 800 w. Elektrotech Zeitschr—Feb. 13, 1902. No. 46335 B.

POWER APPLICATIONS.

Cotton Mills.

Power Plant of Dominion Cotton Mills Co., Magog. Illustrated detailed description of a plant in Quebec, and its equipment. 2700 w. Can Engr—Feb., 1902. No. 45971.

Crane.

Five-Ton Electric Traveling Gantry Crane. Illustrated description of a large gantry crane made in Cleveland, Ohio. 1000 w. Engng—Feb. 7, 1902. No. 46231A.

Dock Equipment.

Electric Cranes and Capstans at Middlesbrough Docks. Illustrated description of an example of the complete equipment of docks with electric cargo appliances. Also editorial. 3000 w. Elect'n, Lond—Feb. 7, 1902. Serial. 1st part. No. 46220 A.

Electric Equipment of Railway Docks, Middlesborough, England. Illustrates and describes a fine plant at Middlesborough, England, for the North-eastern Railway Co's docks. 2200 w. Elec Wld & Engr—Feb. 1, 1902. No. 46012.

Induction Motor.

The Induction Motor. Alfred E. Wiener. Explains the principle of the rotary magnetic field, and the design of the induction motor. Ill. 4800 w. Elec Age—Jan., 1902. No. 46021 C.

We supply copies of these articles. See page 159.

Mining Plant.

A Large Electrical Winding Plant. Lee Murray. Illustrates and describes the plant installed in a mine at Thiede, near Brunswick (Germany). 3900 w. Aust Min Stand—Jan. 9, 1902. No. 46439 B.

The Progress of Electricity in Mining During 1901. Reports steady progress without startling developments, noting the special features. 2200 w. Col Guard—Jan. 31, 1902. No. 46128 A.

Motor Work.

Starting Resistances. Arthur E. Gott. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Discusses incorrectly divided resistances, starting without resistance, and early starters, in this present number. 2700 w. Elec Engr, Lond—Jan. 24, 1902. Serial. 1st part. No. 45995 A.

Power Consumption.

The Power Consumption of Electrically Driven Machines (Force Motrice Applications du Moteur Electrique). M. Derry. From a paper before the congress of the "Syndicat des Usines d'Electricité," giving figures for a great variety of machines. 700 w. Electricien—Dec. 28, 1901. No. 45857 B.

Shipbuilding.

Electric Appliances in Shipbuilding Yards. Sydney F. Walker. Mr. Walker's second paper is devoted to the construction and uses of portable electric tools in all departments of shipbuilding. 3500 w. Engineering Magazine—March, 1902. No. 46385 B.

Electric Transmission at the Palmer Shipyard at Jarrow-on-Tyne (Transmission de Force par l'Electricité dans les Ateliers de la Palmer Shipbuilding and Iron Co. à Jarrow-sur-Tyne, Angleterre). Chas. Dantin. An illustrated description of the electric plant and electric driving in the shops and yard. 3000 w. Génie Civil—Feb. 1, 1902. No. 46344 D.

Tide-Indicator.

Description of an Electrical Tide-Indicator. L. Y. Schermerhorn. Illustrated description of an apparatus that has been in successful operation since Aug. 26, 1901. 1500 w. Pro Engrs' Club of Phila—Jan., 1902. No. 46039 D.

Tool Operation.

Electrical Operation of Tools. Abstract of a lecture by Robert T. Lozier before the New York Electrical Society. Discusses the economy, increased output, convenience, &c. 2400 w. Mach, N. Y—Feb., 1902. No. 46079.

MISCELLANY.

Electrical Development.

Twenty Years of Electrical Development. Charles T. Child. A review of progress from 1882 to 1902. 5200 w. Elec Rev, N Y—Feb. 15, 1902. No. 46283.

Europe.

Electricity in Europe Twenty Years Ago and To-day. A statement of such facts as will show a comparison between the use of a score of years ago and today. 3800 w. Elec Rev, N Y—Feb. 15, 1902. No. 46290.

Gutta Percha.

Gutta Percha in the Philippines. J. Orton Kerbey. Information from advance sheets of the Philippine Commission's reports. 1800 w. Elec Wld & Engr—Feb. 1, 1902. No. 46013.

Lightning Protection.

Lightning and Lightning Protectors (Ueber Blitz und Blitzableiter). F. Wellisch. A review of the theory and practice of lightning protection. 4500 w. Oesterr Wochenschr f d Oeffent Baudienst Jan. 4, 1902. No. 46349 B.

Pan-American.

Electricity at the Recent Buffalo Exposition. Comments on the illuminations and electrical exhibits, giving highest praises. 3300 w. Engng—Jan. 24, 1902. No. 45980 A.

Stray Currents.

See Electrical Engineering, Communication, Street and Electric Railways.

Terminology.

Technical Terminology. Calls attention to some of the errors in terminology, and also to terms susceptible of improvement. 1500 w. Elec Rev, Lond—Feb. 14, 1902. No. 46449 A.

GAS WORKS ENGINEERING

Acetylene.

Acetylene Gas. A report of progress. 1200 w. Gas Wld—Feb. 1, 1902. No. 46123 A.

Lighting with Dissolved Acetylene (Société Française de Physique). A paper before the above society on the present state of lighting with acetylene dissolved in acetone. 1500 w. Revue Technique—Jan. 10, 1902. No. 46363 D.

Address.

Mr. Percy Griffith on Gas Supply. Address to the Society of Engineers, London. Deals with various aspects of gas supply and describes a new development of the Scott Snell self-intensifying gas lamps.

3000 w. Gas Wld—Feb. 8, 1902. No. 46-216 A.

Benzol.

Commercial Benzol. Dr. Fritz Frank. Abstract translation from *Die Chemische Industrie*. Reviews its history, describes methods of testing, and enumerates its uses. 3000 w. Gas Wld—Feb. 1, 1902. No. 46122 A.

Enrichment of Gas by Benzol. M. A. Lecomte. Illustrates and describes apparatus used for enrichment of benzol, discussing points in this method of enrichment. 2300 w. Gas Engrs' Mag—Jan. 10, 1902. No. 45977 A.

Blast-Furnace Gases.

Comparison of Cost of Operating an Iron Smelting Plant by Gas Engines Using Waste Blast Furnace Gas, and by Gas Fired Boilers and Steam Engines. William M. Chatard, Henry J. Botchford and Emley M. Holcombe. Graduation thesis. A report of experimental investigations with results. 2500 w. Stevens Ind—Jan., 1902. No. 45932 D.

The Purification of Blast-Furnace Gas (Beiträge zur Frage der Gichtgasreinigung). Bernhard Osann. A description of methods of cleansing blast-furnace gas, with estimates of the cost. 6500 w. Stahl u Eisen—Feb. 1, 1902. No. 46339 D.

Carbonization.

Improvement in Carbonization in Recent Years. E. W. Smith. Read before the Eastern Counties Gas Managers' Assn. Discusses such developments as are within the reach of small and medium sized works. 2700 w. Gas Engrs' Mag—Jan. 10, 1902. No. 45976 A.

Conveying Machinery.

Criticisms on Construction of Coal and Coke Handling Plant at Zurich Gas Works. Archibald Little. An investigation of the question of suitability in design of the coal and coke conveying machinery in its situation at Zurich, and adaptability for similar duty in other towns. 6000 w. Jour Gas Lgt—Feb. 4, 1902. Serial. 1st part. No. 46214 A.

Fuel Gas.

An American Fuel-Gas Method and Its Applications. Explains the preparation of the fuel, and its utilization. 1500 w. Jour Gas Lgt—Jan. 21, 1902. No. 45948 A.

Hints on Extending the Uses of Coal Gas. The present article is based on the experience of the writer in connection with the introduction of gas as a heating agent in trade and factory processes. 4000 w. Gas Wld—Feb. 8, 1902. No. 46215 A.

Natural Gas and Other Fuels. A comparison. Abstract of results obtained by Mr. Samuel T. Murdock in an elaborate series of tests concerning the relative value of fuels used in stoves such as are used in heating living rooms of dwellings. 2500 w. R R Gaz—Feb. 7, 1902. No. 46-114.

The Changing Use of Gas. Alton D. Adams. Discusses the tendency to use gas for heating purposes instead of illumination. 1100 w. Sci Am—Feb. 15, 1902. No. 46205.

Gasholders.

A Holder Foundation on Quicksand. C. A. Learned. Read at meeting of New England Gas Engrs. Describes the location, near Meriden, Conn., and the materials on which the foundation for a steel tank holder was constructed, and the methods used. 1800 w. Am Gas Lgt Jour—Feb. 24, 1902. No. 46476.

Gas Stoves.

The Fitting of Gas Stoves. From *The Ironmonger*. Considers the use of gas stoves and the best methods of erecting and fitting them. 3000 w. Gas Wld—Jan. 25, 1902. No. 46002 A.

High Pressure.

High-Pressure Gas Lighting in the City. An account of lighting by Sugg's high-pressure burners in London, with remarks on certain features. 2200 w. Jour Gas Lgt—Feb. 4, 1902. No. 46213 A.

Invention.

The Trend of Gas Invention. An examination of new invention as revealed by the specifications published during the last year, with remarks on the comparison to be made between Great Britain and other countries in this industry. 2300 w. Jour Gas Lgt—Jan. 21, 1902. No. 45947 A.

Legal Relations.

The Legal Relations Between Gas Supply Undertakings and Consumers. Considers enactments and judgments, in England, bearing upon points connected with the relations of gas undertakings with consumers who are in financial difficulties. 3000 w. Jour Gas Lgt—Feb. 11, 1902. Serial. 1st part. No. 46434 A.

Mixed Gas.

A Continuous Process for Making a Mixed Gas of Uniform Composition. An abstract translation of an article by Dr. Besenfelder, in the *Journal für Gasbeleuchtung*. Gives a description of his new process for making gas, and reviews the principles underlying other processes. 2800 w. Jour Gas Lgt—Jan. 21, 1902. Serial. 1st part. No. 45949 A.

Oldham, Eng.

New Carburetted Water Gas Plant at Oldham. Illustrated description of new plant. 1800 w. Jour Gas Lgt—Jan. 28, 1902. No. 46121 A.

Photometry.

The Table Photometer and the Standard Pentane Lamp. Abstract of description of the lamp and its accessories, and the

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method of using them as given by Dr. Frank Clowes, with discussion. 4000 w. Jour Gas Lgt—Feb. 11, 1902. No. 46436A.

Power Gas.

Improvements in Power-Gas Plants (Neuerungen an Kraftgas-Anlagen). H. Gerdes. A description of the water-gas plant of Pintsch, in which the carbonic oxide is drawn off separately for use in gas engines. The improved pressure regulator is described. Paper before the Verein Deutscher Maschinen Ing., with discussion. 2 plates. 6000 w. Glasers Ann—Jan. 15, 1902. No. 46301 D.

Retorts.

Inclines and Their Feeding Arrangements. The present article discusses the inclined system and its economy. 1800 w. Jour Gas Lgt—Jan. 28, 1902. Serial. 1st part. No. 46119 A.

Statistics.

Gas Manufacture. Arthur L. Hunt. Extracts from the Bulletin No. 123, Jan. 3, 1902, of the Twelfth Census of the United States. Statistics concerning the operations of establishments engaged in the manufacture of gas for sale, including municipal plants, but not private plants. 4000 w. Pro Age—Feb. 1, 1902. No. 45925.

Welsbach.

Gas Companies, the Welsbach Company, and the trade. Norton H. Humphreys. Discusses the present state of affairs in England and the experience of the Welsbach Company. 2800 w. Jour Gas Lgt—Feb. 11, 1902. Serial. 1st part. No. 46435 A.

The Welsbach Crisis. A report of the recent meeting of the investors of capital in the Welsbach Company in England, with editorial comment. 6500 w. Jour Gas Lgt—Jan. 21, 1902. No. 45950 A.

INDUSTRIAL ECONOMY

Alcohol.

Progress in Alcohol Lighting (Progrès Réalisés dans les Applications Industrielles de l'Alcool. Eclairage). Louis Denayrouze. A review of the great advance made in alcohol lighting in France in the last three years. 1500 w. Mem d l Soc d Ing Civils de France—Dec., 1901. No. 46379 G.

The Alcohol Motor. Ernst Neuberg. An account of experiments in connection with the competition for alcohol motors, carried out in the gas engine laboratory of the Technical High School of Berlin. 1700 w. Auto Jour—Feb., 1902. No. 46483 A.

The Problem of Alcohol. Discussion of the Applicability of alcohol to the operation of explosion engines, and the experiments made in France and other places. 2500 w. Auto Jour—Feb., 1902. No. 46485 A.

Apprentices.

What Can Our Schools Do for Foundry Apprentices? P. Kreuzpointner. Discusses school training and what should be demanded of apprentices. 4800 w. Jour Am Found Assn—Feb., 1902. No. 46174.

Coal Trade.

American Coal in Europe. Discusses the important factors in the creation of a permanent export trade. 1500 w. U S Cons Repts, No. 1258—Feb. 6, 1902. No. 45992 D.

Commerce.

Our Foreign Commerce in 1901. Extracts from the Review of the World's Commerce, introductory to Commercial Relations of the United States, 1901. 3700 w. U S Cons Repts, No. 1269—Feb. 18, 1902. No. 46249 D.

Education.

Education of Railway Mechanical Engineers. C. V. Kerr. Gives suggestions based on the successful practice of leading engineering schools. Followed by general discussion. 8500 w. W Ry Club—Jan. 21, 1902. No. 46252 C.

Prussian Industrial Schools (Die Preussischen Maschinenbauschulen). Th. Peters. An account of the recent organization of the trade and industrial schools, with a review of their development. 2400 w. Zeitschr d Ver Deutscher Ing—Jan. 11, 1902. No. 46303 D.

Reform in Mathematical Education. Robert H. Smith. A discussion of the plan advocated by Prof. John Perry. 5400 w. Engr, Lond—Feb. 7, 1902. No. 46238 A.

The Needs of Industrial Education in America. A topical discussion. I. With Reference to the Schools. Edgar Marburg. II. With Reference to the Machine Trades. Samuel W. Vauclain. III. With Reference to the Building Trades. John M. Shrigley. Followed by general discussion. 14300 w. Pro Engrs' Club of Phila—Jan., 1902. No. 46037 D.

The Technical Education of Railway Apprentices in France. A description of the educational system afforded by apprenticeship classes of the Chemins de fer de l'Est. 4800 w. Engr, Lond—Jan. 24, 1902. No. 45986 A.

Eight-Hour Day.

The Eight-Hour Bill. Testimony of the

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iron interests before the House Committee on Labor. 3700 w. Ir Age—Feb. 20, 1902. No. 46298.

The French Mine-Owners and the Eight Hours' Day. Editorial review of the recent agitation of this subject in France, and the information drawn out by questions to mine owners upon the probable results. 1700 w. Ir & Coal Trds Rev—Feb. 7, 1902. No. 46226 A.

Exposition.

The Düsseldorf Exposition of 1902 (L' Exposition Régionale de Düsseldorf en 1902). J. Dujardin. A general description of the exposition to be opened in the spring of 1902, with illustrations of the buildings, and a review of the economic situation in Germany at the close of 1901. 2000 w. Génie Civil—Feb. 8, 1902. No. 46346 D.

French Patent Office.

French Patent Legislation (Legislation Industrielle). An official circular giving notice of the establishment of the French patent and trade-mark office at the "Conservatoire National des Arts et Metiers." 1100 w. Electricien. Nov. 9, 1901. No. 45850 B.

Germany.

The German Iron Industry. Editorial review of the features of special interest, especially the increase of exports, and diminution of the imports. 1600 w. Engr, Lond—Feb. 14, 1902. No. 46459.

The Iron Industries of Germany. Information concerning the iron ore, the iron works, general conditions and the market. 1000 w. U S Cons Repts, No. 1270—Feb. 19, 1902. No. 46248 D.

Overcrowding.

Industrial Redistribution: the Crux of the Overcrowding Question. William Leonard Madgen. A discussion of conditions in London, England. Also discussion. 1400 w. Jour Soc of Arts—Feb. 14, 1902. No. 46410 A.

Peace Conference.

The Conference for Industrial Peace. Oscar S. Straus. An account of the recent conference in New York, and the benefits hoped to be derived from it. 2000 w. N Am Rev—Feb., 1902. No. 45919D.

Premium Plan.

The Premium Plan at the Works of David Rowan & Company—Piece Work, the Premium Plan, and Mr. Taylor's Plan Discussed. E. G. Herbert. 2200 w. Am Mach—Feb. 20, 1902. No. 46403.

The Premium System. An explanation of the system, discussing its advantages, and the workmen's objections, and hoping to consider every phase of the question. 2000 w. Engr, Lond—Jan. 24, 1902. Serial. 1st part. No. 45985 A.

Indexes.

Card Indexes. Prof. H. Wade Hibbard. Extracts from a paper on "Engineering Periodicals and the Card Index," describing the best method of indexing publications, books, drawings, and other technical documents. 2400 w. Eng Rec—Feb. 8, 1902. No. 46167.

Industrial Commission.

Industrial Commission on Railways. A summary of the commissions recommendations on and discussion of railway affairs. 8200 w. Ry Age—Feb. 7, 1902. No. 46155.

Labour Management.

Emotion and Reason among British Workmen. Percy Longmuir. A discussion of the impelling motives among workmen in their conduct of labour matters, showing the unfortunate effects of appeals to emotion, and calling for a national consideration of important questions. 3000 w. Engineering Magazine—March, 1902. No. 46384 B.

Over Production.

The Mischievous Fallacy of Over-Production. George H. Hull. Showing the utter fallacy of the theory of over-production, and establishing the theory of temporary surplus production. The manner in which the fallacy effects trade unions, strikes and fluctuating prices, is clearly shown. 3500 w. Engineering Magazine—March, 1902. No. 46381 B.

Recording.

The Numerical Recording of Shipping and Manufacturing Orders. Kenneth Falconer. A discussion of the applicability of the card index in connection with the recording and filing of shipping and manufacturing orders. 3500 w. Engineering Magazine—March, 1902. No. 46387 B.

Shipping.

The Development of Shipping in the United States. Lewis Nixon. Printed also in the *Cosmopolitan Magazine*. Discusses points in the oversea commerce, and the importance of American shipowning. 2800 w. Naut Gaz—Feb. 13, 1902. No. 46268.

Steel Corporation.

The United States Steel Corporation. A copy of the preliminary report to the stockholders. 3500 w. Ir Age—Feb. 6, 1902. No. 46101.

The United States Steel Trust (Der United States Steel Trust). A general review of the organization, aims and effect of this great corporation. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 25, 1902. No. 46372 B.

Ship Subsidy.

New French Ship-Subsidy Bill. Gives the act passed by the French Chamber, intended to encourage the French shipping interests, and improve the merchant marine. 4500 w. U S Cons Repts, No. 1267—Feb. 17, 1902. No. 46184 D.

We supply copies of these articles. See page 150.

The Ship Subsidy Bill. Editorial discussion of the present position of the United States. 1200 w. Sci Am—Feb. 1, 1902. No. 45956.

Works Management.

Money-Making Management for Workshop and Factory. C. U. Carpenter. Mr. Carpenter's second paper discusses a concrete example of successful shop administration, and shows the detailed methods employed. 3000 w. Engineering Magazine—March, 1902. No. 46382 B.

MARINE AND NAVAL ENGINEERING

Anchors.

Anchors. Comdr. A. S. Thomson. Abstract of a paper read before the London Chamber of Commerce. Reviews the history of anchors, the improvements made, etc., giving interesting information. 2000 w. Naut Gaz—Feb. 6, 1902. No. 46176.

Ballasting.

The Ballasting of Modern Tramp Steamers. E. C. Chaston. Read before the North-East Coast Inst. of Engrs. and Shipbuilders. Shows the short-sighted policy of sending vessels to sea without sufficient ballast. 1800 w. Naut Gaz—Feb. 13, 1902. No. 46269.

Battleships.

Japanese Battle ship "Mikasa." An outline of the six battleships built in England for the Japanese Government, with full description of the latest. Ill. 3700 w. Engng—Feb. 7, 1902. No. 46230 A.

Launching a Battleship from the Congressional Ways. William M'Adoo. Traces the steps necessary before a warship may be built. 7800 w. N Am Rev—Feb., 1902. No. 45920 D.

Boilers.

See Mechanical Engineering, Steam Engineering.

British Navy.

Naval Engineers. D. B. Morison. Read before the N. E. Coast Inst. of Engrs and Shipbuilders. Report on memorandums submitted to the First Lord of the Admiralty on July 16, 1901, with reference to the unsatisfactory condition of the engineer branch of His Majesty's Navy. Also editorial. 10400 w. Engng—Feb. 14, 1902. Serial. 1st part. No. 46457 A.

Collision Case.

Interesting Collision Case. Gives the opinion of the Court of Appeals by Judge Lacombe, in the Grand Traverse-Livingstone case, reversing the decree of the district court. 2100 w. Marine Rev—Feb. 6, 1902. No. 46154.

Cruisers.

New Japanese Cruisers Nütaka and Tsushima. Illustrates and describes these absolutely Japanese vessels; designed and built by Japanese, and all their material, armor, machinery, ammunition and guns obtained from the Japanese factories. 1400 w. Eng, Lond—Jan. 24, 1902. No. 45987 A.

Displacement.

Distribution of Displacements of Ships. Theodore Lucas. A discussion of the qualities that are affected by variations in the distribution of the bulk of the displacement, resistance, &c. 1800 w. Naut Gaz—Feb. 6, 1902. No. 46175.

Dock Equipment.

See Electrical Engineering, Power Application.

Economy.

The Growth of Economy in Marine Engineering. W. M. McFarland. The first of an important series of articles dealing with the development of steam economy in the marine engine from the beginning of steam navigation to the present. The first paper deals with the period of the simple engine. 4000 w. Engineering Magazine—March, 1902. No. 46383 B.

Floating Dock.

Official Test of Algiers Floating Dry Dock. Extract from the report on this dock at New Orleans, with the docking of the collier Sterling and the battleship Illinois, giving changes recommended. 1300 w. Marine Rev—Jan. 30, 1902. No. 45965.

The New Bermuda Floating Dock. Illustrated description of this recently launched floating dock, which is the largest and heaviest yet constructed. 2500 w. Engng—Feb. 14, 1902. No. 46454 A.

Lake Steamer.

Splendid Lake Passenger and Freight Steamer. Profile and deck plans of a new passenger and freight steamer, which has many original features, now in progress of construction. 800 w. Naut Gaz—Feb. 20, 1902. No. 46475.

Liner.

The White Star Liner Athenic. Illustration with brief description of one of three exactly similar ships to be added to those sailing from London to New Zealand via the Cape. 350 w. Engr, Lond—Feb. 14, 1902. No. 46464 A.

We supply copies of these articles. See page 159.

River Boat.

New James River Night Boat. Illustration with description of the "Brandon," the first of two new passenger steamers. 800 w. Naut Gaz—Feb. 20, 1902. No. 46473.

Sailing Vessels.

Steamers and Sailing Vessels (Vapeurs et Voiliers). M. Kerlago. A comparison between steam and sail navigation and transportation. 3000 w. Revue Technique—Jan. 25, 1902. No. 46365 D.

Shipbuilding.

Risdon Iron Works, San Francisco. General illustrated description of this new shipbuilding plant, and its equipment. 4000 w. Marine Engng—Feb., 1902. No. 46016 C.

See Electrical Engineering, Power Applications.

Shipping.

See Industrial Economy.

Ship Resistance.

Tubes With Sides and Without, in Ship Resistance—An Example from Lord Kelvin. Marston Niles. A study of hydromechanics, with diagrams, giving theoretical conclusions. 5800 w. Sci Am Sup—Feb. 1. 1902. No. 45963.

Ship Subsidy.

See Industrial Economy.

Shipyards.

Machine Tools in Ship Yards. Waldon Fawcett. An illustrated article describing the large machine tools in use at Newport News, Va. 2000 w. Mod Mach—Feb., 1902. No. 46015.

Steamers.

Built on the Lakes for Ocean Service. Illustrated descriptions of steamers Minnetonka and Minnewaska, of 7,000 tons capacity each, which are to be taken in sections to the Atlantic seaboard. 1600 w. Marine Rev—Jan. 30, 1902. No. 45966.

Tail Shafts.

Propeller Shafts and New Form of Stern Tube. Extract from the presidential address of Mr. John Corry, at a recent meeting of the Inst. of Marine Engrs., discussing tail shafts and stern tube bearings. 1800 w. Marine Engng—Feb., 1902. No. 46018 C.

Towing.

Tow Barges as General Freight Carriers. Edwin B. Sadtler. Considers seatowing, giving a sketch of a barge suitable for handling freight of a miscellaneous character. 1500 w. Marine Engng—Feb., 1902. No. 46017 C.

Yachts.

The Emperor of Germany's New American Yacht. Description of the Meteor III, with drawing showing sail plan. 3000 w. Naut Gaz—Feb. 20, 1902. No. 46472.

The Palatial Hohenzollern. Illustration, with brief description. 600 w. Naut Gaz—Feb. 20, 1902. No. 46474.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol.

Competition of Alcohol Motors and Automobiles (Concours Générale des Moteurs et Automobiles à Alcool). M. Ringelmann. A short review of an exhibition and competition of stationary and automobile alcohol motors held in Paris, 1901. 2000 w. Mem d l Soc d Ing Civils de France—Dec., 1901. No. 46378 G.

Construction.

International Automobile Construction. A review of the novel constructions exhibited recently in Paris, Ill. 1700 w. Auto Topics—Feb. 15, 1902. No. 46185.

Cylinder Jackets.

Non-Freezing Liquids for Cylinder Jackets. E. E. Keller. A report of investigations made, giving curves of freezing and boiling points. 1500 w. Horseless Age—Feb. 12, 1902. No. 46181.

Electric Carriage.

The De Dion-Bouton Electric Carriage. From *La France Automobile.* An illustrated detailed description. 1000 w. Horseless Age—Feb. 2, 1902. No 46182.

Endurance Contest.

Lessons from the Automobile Endurance Contest. Prof. R. H. Thurston. Comments on the run which began at New York and terminated at Rochester, and the lessons of the test. 1800 w. Sci Am Sup—Feb. 1, 1902. No. 45961.

Energy Consumption.

Energy Consumption and Electric Automobile Performance. H. W. Alden. Calls attention to the importance of a high efficiency in the motors and gearing. 800 w. Elec Wld & Eng—Feb. 15, 1902. No. 46294.

Explosion Motors.

Improvements in Explosive Motors. A review of the more recent developments,

due largely to the automobile, especially considering French progress in motors. 3000 w. Ir Trd Rev—Jan. 30, 1902. No. 46019.

Gasoline Engines.

The Self-Contained Motor. Calls attention to the need of the self-contained gasoline motive power equipment, capable of being connected directly to the driving wheels, showing that it is possible. 700 w. Horseless Age—Feb. 5, 1902. No. 46090.

Gasoline Racer.

Notes on a Gasoline Racer Design. F. D. Howe. Remarks on the kind of machine likely to be evolved for short races, with sketches. 1100 w. Horseless Age—Feb. 12, 1902. No. 46180.

Gears.

Planetary Gear Calculations. P. M. Heldt. A mathematical consideration of this subject. 1200 w. Horseless Age—Feb. 5, 1902. No. 46092.

Ignition.

Gas and Gasoline Engine Ignition. Albert Stritmatter. Considers the different methods of ignition in common use in the present article. 2000 w. Am Mfr—Feb. 6, 1902. Serial. 1st part. No. 46152.

Lecture.

Existing Automobile Mechanism. Hiram Percy Maxim. A lecture before the Automobile Club of America. Especially considers the gasoline engine and the electric storage battery as applied to the automobile. 3700 w. Auto Mag—Feb., 1902. No. 45901 C.

Mors Carriage.

The New 15 Horse Power Mors Carriage. Drawings of the latest production of this company with description of the novel fixtures. 900 w. Horseless Age—Feb. 5, 1902. No. 46093.

Motor Cycle.

Benzine Motor Cycle. Illustrates and describes a machine made in Munich, Bavaria, and its action. 1200 w. Sci Am Sup—Feb. 1, 1902. No. 45962.

Paris Show.

The Automobile and Cycle Show at Paris, December, 1901 (Le Salon de l' Automobile et du Cycle). F. Drouin. Various illustrated notes on the automobiles and motors exhibited. 2500 w. Génie Civil—Jan. 25, 1902. No. 46343 D.

The Paris Automobile Show. Alex Schwalbach. An account of the recent very successful annual exhibition, with illustrated description of the most interesting features in the exhibits. 6300 w. Auto Mag—Feb., 1902. No. 45900 C.

Pressure.

The Pressure to be Used on an Electromobile. Sydney F. Walker. Some remarks on the subject of the best pressure to be used and other matters concerning accumulators for motor vehicles. 900 w. Autocar—Jan. 25, 1902. No. 46001 A.

Stables.

Private Automobile Stables. Illustration, with description, of buildings being erected in East 75th street, New York, with every convenience for the maintenance and care of steam, gasoline, or electric machines. 900 w. Horseless Age—Feb. 19, 1902. No. 46401.

Standardization.

Lines of Standardization. Albert L. Clough. On the control of gasoline carriages, the position of the operator, clutch levers position, &c. 800 w. Horseless Age—Jan. 29, 1902. No. 45941.

Steam Vehicles.

The Stanley Brothers New Steam Carriage. A. L. Clough. Describes the interesting features, the chief of which is the watertube boiler. 1100 w. Horseless Age—Jan. 29, 1902. No. 45943.

The White Steam Carriage. Illustrated detailed description. 2700 w. Horseless Age—Jan. 29, 1902. No. 45942.

Tires.

Tires for Heavy Vehicles. Arthur L. Stevens. Discusses the subject of a practical tire, presenting results of actual experience. 3000 w. Horseless Age—Feb. 5, 1902. No. 46091.

Vibration.

Vibration in Automobiles. M. Drouin. Translated from *Le Génie Civil.* Considers means of diminishing the vibration due to the motor. Mathematical. 3200 w. Auto Jour—Feb., 1902. Serial. 1st part. No. 46486 A.

HYDRAULICS.

Flow.

The Measurement of Water. C. V. Seastone. A paper, slightly condensed, read before the Indiana Engng. Soc. Describes methods of measuring the flow of water by orifices, weirs, nozzles, Venturi meters, and jet meters. Ill. 2100 w. Eng Rec—Feb. 15, 1902. No. 46256.

Pump Eciency.

The Efficiency of Compound Centrifugal Pumps. F. G. Hesse. Develops a formula for the efficiency of a compound pump, which indicates that, for a given head the efficiency will increase with the number of stages or pumps in series. Ill. 1000 w. Jour Assn of Engng Soc—Dec., 1901. No. 45930 C.

Pumps.

See also Mechanical Engineering, Miscellany.

Turbines.

Modern Hydraulic Turbines (Sulle Turbine Idrauliche Moderne). W. Zup-

pinger. An exhaustive discussion of the modern theory of turbine construction, with descriptions of various types and comparisons of their performances. Serial. Part 1. 1500 w. L'Industria—Jan. 19, 1902. No. 46380 D.

MACHINE WORKS AND FOUNDRIES.

Crane.

See Electrical Engineering, Power Applications.

Cupolas.

Improvements in Cupolas. Edward Kirk. Describes the first cupola furnaces used in the United States, and their working; and the improvements made are traced and discussed. 4500 w. Foundry—Feb., 1902. No. 46035.

Dies.

A Cutting Off and End Finishing Die, and an Accurate Sectional Die with a Chute Feed, and Finger Stripper. Joseph V. Woodworth. Illustrated detailed descriptions. 1100 w. Am Mach—Feb. 6, 1902. No. 46097.

A Piercing and Blanking Die, and a Novel Bending and Forming Die. William Doran. Illustrated descriptions. 1600 w. Am Mach—Feb. 6, 1902. No. 46096.

Dies for a Sheet Metal Bracket. Joseph V. Woodworth. Illustrated description of four dies and their use. 1100 w. Am Mach—Feb. 20, 1902. No. 46402.

Four "Follow" Dies. Joseph V. Woodworth. Illustrated description of four applications of the gang and follow principle for articles of sheet metal to be pierced, bent, formed or drawn, and finished in one operation. 900 w. Am Mach—Feb. 13, 1902. No. 46193.

Making a Large "Safety" Pin. William Doran. Describes and illustrates the dies and fixtures used in the manufacture of safety pins for horse blankets. 1100 w. Am Mach—Feb. 20, 1902. No. 46404.

Foundry.

The Vulcan Foundry, Newton-le-Willows. General history of these important works with illustrations, the improvements and developments, and some of the locomotives built. 3000 w. Engr, Lond—Jan. 31, 1902. No. 46132 A.

Grinding Machine.

The Hibbard Reversible Grinding Machine. Illustrates and describes a machine for circular grinding in which the work revolves. 1400 w. Ir Age—Feb. 6, 1902. No. 46098.

Hardening.

Hardening Rings. E. R. Markham. Describes treatment given large tool-steel rings. Ill. 800 w. Am Mach—Feb. 6, 1902. No. 46094.

Success in Hardening Steel. E. R. Markham. Practical suggestions about the fire, the steel, and the method of treatment. 3000 w. Mach, N Y—Feb., 1902. No. 46075.

Lathes.

Turret Lathe Fixture. Joseph V. Woodworth. Illustrated description of a handy attachment for forming irregular pieces. 1200 w. Mach, N. Y—Feb., 1902. No. 46077.

Machine Tools.

28-Ft. Boring and Turning Mill. Illustrated description of a large machine having novel features of interest. 800 w. Engng—Jan. 24, 1902. No. 45981 A.

Molding.

The Molding Machine. S. H. Stupakoff. Considers the subject of molding and the labor saving devices used. Ill. 3000 w. Jour Am Found Assn—Jan., 1902. No. 45991.

Planers.

Some Inventions in Planer Driving and Reversing Mechanisms. Howard A. Coombs. Illustrates and describes some ingenious devices. 2500 w. Am Mach—Jan. 30, 1902. No. 45927.

Portable Machines.

Portable Electrically-Driven Machine Tools. An illustrated description of recently designed machine tools for work connected with the manufacture of large electric generators. 700 w. Engr, Lond—Jan. 31, 1902. No. 46134 A.

Power Consumption.

See Electrical Engineering, Power and Transmission.

Premium Plan.

See Industrial Economy.

Punching.

Experiments on the Work of Machine Tools (Expériences sur le Travail des Machines-Outils). M. Codron. Another installment, this time dealing with punching machinery, of the author's important series of articles. Illustrations and diagrams. 8000 w. Bull Soc d' Encouragement—Jan., 1902. No. 46391 G.

Screw-Cutting.

Cutting Square Threaded Screws. W. S. Rowell. An illustrated description of method and tools. 2000 w. Am Mach—Feb. 13, 1902. No. 46192.

Screw Machines.

Camming Automatic Screw Machines. C. L. Goodrich. An illustrated detailed description. 2200 w. Ir Age—Feb. 20, 1902. No. 46299.

Slotting Machine.

Slotting Machine with Screw Driving Gear (Stossmaschine mit Schraubenantrieb des Stössels). Alexander Klehe. An illustrated description of a tool for machining the pole seats of large dynamo

We supply copies of these articles. See page 159.

frames. 800 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1902. No. 46307 D.

Tool Operation.

See Electrical Engineering, Power Applications.

Turning Mill.

A Notable Boring and Turning Mill. Illustrates and gives particulars of the 28-foot boring and turning mills installed in the Westinghouse shops in Pittsburg. 1100 w. Mach, N. Y—Feb., 1902. No. 46074.

Works.

The Brush Electrical Engineering Company. Illustrations with description of the works at Loughborough, England. 2200 w. Engng—Feb. 7, 1902. Serial. 1st part. No. 46229 A.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Armor-Plates.

Beardmore Armor Plates. An account of tests of these plates, made in Glasgow, with illustrations. 800 w. Engng—Jan. 31, 1902. No. 46130 A.

New Armor Plate Hardening Process. Describes an improved and economical method of hardening the face of the plates to any required depth, and toughening the face of the hardened portions. Patented by Benton Knott Jamison. 1700 w. Am Mfr—Feb. 6, 1902. No. 46153.

Hollow Cylinders.

Tests of Hollow Cylinders Subjected to Internal Pressure (Essais à la Traction sur Cylindres Creux Soumis a des Pressions Intérieures). Dr. C. de Szily. Paper before the Budapest Congress of the International Assoc. for the Testing of Materials, giving the theory and results of experiments. Serial. 1st part. 4000 w. Revue Technique—Jan. 10, 1902. No. 46362 D.

Impact Tests.

Impact Tests on Notched Steel Bars. Editorial on the plan advocated for the testing of notched bars, which are claimed to be extremely effective in showing brittleness or lack of homogeneity in structural steels. 1100 w. Engng—Feb. 7, 1902. No. 46234 A.

Springs.

Plate Springs. Results of extensive investigations are given with a table allowing of their practical application. 1400 w. Engr, Lond—Feb. 14, 1902. No. 46460 A.

Springs. A. A. Cary. Abstract of Mr. Cary's remarks in discussion of Prof. Benjamin's paper before the recent meeting of the A. S. M. E. and of his contribution to the topical discussion on "A Spring Testing Machine." 2500 w. Am Mach—Feb. 20, 1902. No. 46406.

Steel.

The Behavior of Steel Under Stress. C. H. C. Wright. A discussion of the peculiar properties and behavior of this material and its possiblities in structural work. 3000 w. Can Archt—Jan., 1902. No. 45903 C.

Strains.

The Elastic Line of Polyphase Machines with Large Diameters (Die Elastische Linie von Drehstrommaschinen mit Grossen Durchmessern). Hans Linsenmann. An elaborate mathematical discussion of the mechanical strains caused by the magnetic forces acting in the machine. Diagrams. Serial. 2 parts. 6000 w. Elektrotech Zeitschr—Jan. 30, Feb. 6, 1902, No. 46325 each B.

Testing Machines.

Mohr and Federhaff Testing Machines (Machines à Essayer les Materiaux de Construction Mohr et Federhaff). An illustrated description of various types of machines for testing materials made by this German firm. 2000 w. Revue Technique—Jan. 25, 1902. No. 46364 D.

MEASUREMENT.

Anemometer.

On a Miniature Anemometer for Stationary Sound Waves. Bergen Davis. Describes experiments undertaken to determine the relation between the amplitude of vibration and the rate of rotation, and also the influence of the size of the anemometer cups. 1000 w. Am Jour of Sci—Feb., 1902. No. 46033 D.

Flow.

See Mechanical Engineering, Hydraulics.

Speed Variation.

A New Apparatus for Measuring the Variation of Speed of a Flywheel During One Revolution. E. W. Mix. Describes an ingenious electro-mechanical apparatus for measuring the pulsation and also the angular variation of the moving parts involved. Ill. 800 w. Elec Wld & Engr—Feb. 8, 1902. No. 46158.

POWER AND TRANSMISSION.

Air Compressor.

A Vertical Compound Air Compressor at the "Minister Stein" Mine, Westphalia (Stehender Verbund Kompressor auf Zeche "Minister Stein"). R. Goetze. A well illustrated description of this air compressor, and account of tests and operation. 1 plate. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 1, 1902. No. 46314 D.

Conveying.

A Successful Bag-Conveying System. Illustrated description of a plant in Milton, Mass. 1000 w. Eng News—Jan. 30, 1902. No. 45909.

We supply copies of these articles. See page 159.

Cotton Mill.

See Electrical Engineering, Power Applications.

Economy.

Power and Its Economical Transmission. Extracts from a lecture by Henry Souther, delivered in the Board of Trade Building, Toronto, comparing the losses in gearing and belt transmission with the advantages of electric driving. 3500 w. Can Elec News—Feb., 1902. No. 46186.

Elevators.

Elevators: Their Construction and Operation. William Baxter, Jr. An illustrated article discussing in this number the hydraulic elevator, sheave and rope arrangement, methods of control, governors, &c. Ill. 3400 w. Steam Engng—Feb., 1902. Serial. 1st part. No. 46414.

Energy.

The Economical Conversion and Transmission of Energy. William C. L. Eglin. A study of economical methods under the heads of generators or converters, transmission systems, motors or consumption devices, and load factors. 5200 w. Pro Engrs' Club of Phila—Jan., 1902. No. 46038 D.

Gearing.

Gearing. C. F. Blake. The present article deals with calculations connected with the design of gear wheels, velocity ratio, sizing the blanks, &c. Ill. 1500 w. Mach, N. Y—Feb. 1902. Serial, 1st part. No. 46076.

The Strength of Shrouded Gear Teeth. Wilfred Lewis. A report of investigations which seem to indicate that from ¼ to ½ may be added to the strength of teeth by shrouding. 2100 w. Am Mach—Jan. 30, 1902. No. 45926.

The Wear and Friction of Spur Gearing (Beitrag zur Kenntais der Abnutzungs- und Reibungsverhältnisse der Stirnzahnräder). Karl Büchner. An elaborate mathematical discussion of the relations between friction, pressure, surface and wear of spur teeth with many diagrams. Serial. Part I. 2400 w. Zeitschr d Ver Deutscher Ing—Feb. 1, 1902. No. 46315 D.

Power Plants.

An Unusual Method of Constructing Condensing Water Tunnels. Illustrates and describes the tunnels of the power stations of the Manhattan Railway and of the New York Edison Co., consisting of concrete-lined tubes built on launching ways, like boats, floated to the station and then sunk into their final position. 1700 w. Eng Rec—Feb. 8, 1902. No. 46165.

Mechanical Plant of the Albany Station of the New York & Hudson River Railroad Company. Illustrated description of a very compact plant, particularly noteworthy for the forced circulation, hot-water heating system for the buildings, a water proof concrete piping tunnel and a self-sustained steel-plate smoke stack. 2300 w. Eng Rec—Feb. 15, 1902. No. 46255.

Power Plant of the Booth Cold Storage Warehouse, Chicago. Illustrates and describes an interesting mechanical equipment, where the power plant is located in the top story of a nine-story building. The electric part is a two-wire 220-volt system, involving 35 feeders. 3400 w. Eng Rec—Feb. 1, 1902. No. 46068.

The Power Plant of the New United States Mint at Philadelphia. Illustrated description of a plant having a nominal capacity of about 800 h. p. in electric generating units, besides boiler capacity for heating. The article describes the boiler and engine equipment, the generators and motors, the switchboard and the auxiliary plant. 5400 w. Eng Rec—Feb. 15, 1902. No. 46259.

Tunnel Construction for Underground Steam Pipes. Describes a tunnel 460 ft. long, built at the Iowa State College to accommodate electric, gas, water, and steam pipes. 1000 w. Eng Rec—Feb. 8, 1902. No. 46171.

Rope Transmission.

Rope Transmission of Power. E. C. De Wolfe. Extract from a paper before the Indiana Engng. Soc. Explains the important features to be considered in designing a system of rope drives for power transmission. 2500 w. Eng Rec—Feb. 8, 1902. No. 46170.

Spiral Gearing.

A Graphical Determination of the Efficiency of Spiral Gearing. Walter Ferris. An explanation of the application of the graphical method to such problems. 2800 w. Am Mach—Jan. 30, 1902. No. 45928.

Wire Ropes.

Stresses in Wire Ropes. Opinions of different manufacturers in regard to the effects upon the rope, of length of arc of contact on sheave. 1800 w. Mines & Min—Feb., 1902. No. 46148 C.

The Operation of a Wire Rope in Multiple Laps. A discussion by R. D. Seymour of Denver, Colorado, and William Hewitt. Ill. 1600 w. Stevens Ind—Jan., 1902. No. 45933 D.

SPECIAL MOTORS.

Alcohol.

See Mechanical Engineering, Automobiles.

Gas Engines.

Mr. Dugald Clerk on Gas Engines. Extracts from a lecture delivered at the meeting of the Inst. of Engrs. in Scotland. Considers the nature of a gaseous explosion, and describes the mechanical features

of a gas engine. 3800 w. Jour Gas Lgt —Jan. 28, 1902. No. 46120 A.

Recent British and American Gas Engine Tests (Neuere Englische und Amerikanische Versuche on Gasmaschinen). R. Schöttler. A very well illustrated discussion of gas engine experiments, partly a review of papers before the Institution of Mechanical Engineers and the American Society of Mechanical Engineers. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1902. No. 46308 D.

The Design of Gas Engines (Beiträge zur Berechnung der Gasmaschine). Rudolf Barkow. A mathematical discussion of the action of two-cycle gas engines and the amount of compression. 1200 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1902. No. 46306 D.

The Gas Engine and Its Fuel. Abstracts of two lectures recently delivered in England; one by Prof. T. Hudson Beare on Recent Developments of the Gas Engine; the other by Mr. Frederick Grover, on Gas Engines. 2800 w. Gas Wld—Feb. 15, 1902. No. 46442 A.

The Maywood Gas Engine. Illustrations with brief description. 500 w. Am Mach—Feb. 20, 1902. No. 46405.

The Temperature of Gas Engine Cylinders (Untersuchungen über die Wärme der Gasmotorencylinder). Ernst Körting. An illustrated account of measurements to determine the temperature at different points of the cylinder of a 400 H. P. double-acting two-cycle gas engine, with a view to the prevention of injurious expansion of the metal. 1000 w. Zeitschr d Ver Deutscher Ing—Jan. 25, 1902. No. 46312D.

Gasoline Engines.

See Mechanical Engineering, Automobiles.

STEAM ENGINEERING.

Boiler Design.

The Best Improvement in Boiler Design. Committee report and general discussion. 4500 w. Cent Ry Club—Jan., 1902. No. 46136 C.

Boiler Explosion.

An Instructive Boiler Explosion (Eine Lehrreiche Dampfkesselexplosion). C. Bach. A paper giving a fully illustrated account of a boiler explosion at Rosenthal-Blankenstein, Germany, with discussion of the causes and the lessons to be derived, with tables of tests of the boiler material. 6000 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1902. No. 46305 D.

Boiler Explosion at Oldham. A report of the investigation with regard to the circumstances and cause of a boiler explosion which occurred on Oct. 31, with editorial. 3200 w. Engng—Feb. 7, 1902. No. 46236 A.

Boilers.

A New Express Boiler. Illustrations with explanatory notes of new water-tube boilers for first-class torpedo boats. 800 w. Engr, Lond—Feb. 7, 1902. No. 46243 A.

Boilers and Water Supply. F. G. Ansell. The present article discusses the nature of water, and the properties likely to give trouble in the steam-boilers. 3000 w. Elec Engr, Lond—Jan. 31, 1902. Supplement. Serial. 1st part. No. 46124 A.

Firing and Handling Steam Boilers. Charles L. Hubbard. Describes systems of firing and gives suggestions for the care of boilers and their management. 2300 w. Am Elect'n—Feb., 1902. No. 46030.

The Boilers for the New British Warships. Editorial discussion of the design of the different types of steam generators which have been tested, and comparison of the leading particulars. 1800 w. Engng—Jan. 24, 1902. No. 45983 A.

The Lagasse Semi-Multitubular Boiler (Le Générateur Semi-Multitubulaire Système Lagasse). A. Brüll. An illustrated description of a boiler having large water tanks above and below, connected by a great number of vertical water tubes. 1500 w. Bull Soc d'Encouragement—Jan., 1902. No. 46390 G.

The Schütte Boilers of the Steam Yacht "Lensahn" (Die Kessel der Grossherzoglichen Dampfjacht "Lensahn," System Schütte). Hr. Benetsch. A well illustrated description of combined cylindrical and water-tube boilers installed on the yacht of the grand duke of Oldenburg. 3 articles. 1 plate. 3000 w. Schiffbau—Dec. 23, 1901, Jan. 8, 23, 1902. No. 45871 each D.

Fuel Oil.

Tests of Beaumont Oil as Fuel. Report submitted by Prof. James E. Denton of the results of the full value of crude petroleum as used to operate a horizontal return tubular boiler. Ill. 5000 w. Eng & Min Jour—Feb. 1, 1902. No. 46042.

Furnaces.

Furnace Arch Bars. Discusses the arrangement of the rear arch in settings for horizontal tubular boilers. Ill. 1000 w. Locomotive—Dec., 1901. No. 46007.

Mechanical Draft.

The Advantages of Mechanical Draft. H. F. Schmidt. Considers the advantages of mechanical draft as compared with natural draft. Diagrams. 3000 w. Am Elect'n—Feb., 1902. No. 46027.

Pulverized Fuel.

A Rotary Brush System of Feeding Pulverized Fuel to Furnaces. Brief illustrated description of the Hesselmeyer & Schwartzkopff system. 1000 w. Eng News—Feb. 20, 1902. No. 46488.

Safety Valve.

A Valve which Closes Automatically on the Breaking of a Steam Pipe (Ein

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Neues bei Rohrbruch Selbstthätig Absperrendes Dampfventil). Hr. Richter. A paper giving an illustrated description of a valve which automatically shuts off steam from the boilers in case of a steam-pipe explosion. 2000 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1902. No. 46309 D.

Smoke.

Smoke Abatement in St. Louis. William H. Bryan. A review of the history of the smoke movement in St. Louis, discussing the methods that have proved successful and what may yet be accomplished. Ill. 6300 w. Jour Assn of Engng Soc's—Dec., 1901. No. 45929 C.

Successful Smoke Prevention. Illustrated description of a device in use at the shops of the Chicago Bridge & Iron Works. An application of the steam jet, automatic in its operation. 800 w. Ry & Engng Rev—Feb. 8, 1902. No. 46179.

Speed Variations.

See Mechanical Engineering, Miscellany.

Steam Engines.

Steam Engine Trials. Editorial commending a set of rules issued by a Continental firm, for the occasional testing of engines to see whether they are falling away from their early excellence. 1400 w. Engng—Feb. 14, 1902. No. 46455 A.

Steam Hammer.

Steam Hammer Diagrams (Dampfhammer-Diagramme). Prof. Georg Lindner. A well illustrated account of experiments on a steam hammer at Karlsruhe. Germany, with many indicator diagrams and discussion of them. 2400 w. Zeitschr d Ver Deutscher Ing—Jan. 11, 1902. No. 46302 D.

Steam Loop.

The Steam Loop (Der Selbstthätige Dampfkreislauf). Gustav Huhn. Paper before the Verein Deutscher Maschinen-Ingenieure, giving an illustrated description of the system of piping for automatically returning the water of condensation to the boiler. 1100 w. Glasers Ann—Jan. 15, 1902. No. 46300 D.

Steam Turbines.

Some Notes on Steam Turbines. F. J. Warburton. Read before the Northeast Coast Inst. of Engrs. and Shipbuilders, at Newcastle. An illustrated article explaining the various powers of the steam turbine, and how the modern types differ from the earlier. 1800 w. Engr, Lond—Feb. 7, 1902. No. 46245 A.

See also Mechanical Engineering Miscellany.

Superheating.

Steam Superheaters (Les Surchauffeurs de Vapeur). Maurice Miet. A description of recent progress in superheater construction, with illustrations of various types. 3000 w. Génie Civil—Feb. 1, 1902. No. 46345 D.

The Use of Superheated Steam in Locomotives (Die Anwendung von Hochüberhitztem Dampf (Heissdampf) in Locomotivbetriebe). Hr. Garbe. A well illustrated account of the Schmidt system of using highly superheated steam in locomotives with a particular description of the Borsig locomotive exhibited at Paris, and many indicator diagrams. Serial. 2 Parts. 1200 w. Zeitschr d Ver Deutscher Ing—Feb. 1, 8, 1902. No. 46313 each D.

MISCELLANY.

Aeronautics.

Some Aeronautical Experiments. Wilbur Wright. Read before the Western Soc. of Engrs. Discusses mainly the subject of balancing and gives an account of personal work in this field. 4000 w. Auto Jour—Feb., 1902. Serial. 1st part. No. 46484 A.

The Progress of Aerial Navigation and the Experiments of M. Santos-Dumont (Les Progrès de la Navigation Aérienne et les Expériences de M. Santos Dumont). M. Armengaud, Jr. A well illustrated description of Santos-Dumont's experiments and a general review of the development of light-weight motors. 2 plates. 1100 w. Mem d l Soc d Ing Civils de France—Dec., 1901. No. 46376 G.

Acoustics.

A Century of Progress in Acoustics. James Loudon. Read before the Am. Assn. for the Adv. of Science. Refers to the various experimental methods which have been employed in acoustical researches and traces the advances made. 4200 w. Sci Am Sup—Feb. 8, 1902. No. 46089.

Braiding Machine.

The Schürmann Braiding Machine (Die Schürmannsche Flechtmaschine). Prof. Ernst Müller. A well illustrated description of a machine for simultaneously covering, braiding and stranding incandescent light cords, and other electrical conductors. 2000 w. Zeitschr d Ver Deutscher Ing—Jan. 25, 1902. No. 46311D.

Cold Storage.

A Unique Cold Storage Warehouse in Chicago. Illustrated description of a warehouse with the mechanical plant on the top floor, giving details of electrical equipment, etc. 4800 w. Ice & Refrig—Feb., 1902. No. 46025 C.

See also Mechanical Engineering, Power and Transmission.

Heating.

A Practical Air Moistener. An account of experiments conducted by the Bell Tele-

phone Company to secure agreeable temperature conditions in their exchanges. 2800 w. Dom Engng—Feb. 15, 1902. No. 46467 C.

Central Heating and Lighting Plant for the County Buildings, Indianapolis, Ind. Illustrated description of a power house containing 600 H. P. in water-tube boilers and 345 H. P. in engines. With notes on the way the various buildings are heated. 1600 w. Eng Rec—Feb. 22, 1902. No. 46427.

Heating and Ventilating Railway Shops at Elizabethport, N. J. Illustrated description of the plant installed for a number of large shops, the steam being furnished from a central station. 2200 w. Eng Rec —Feb. 22, 1902. No. 46432.

Operating Results with Central Heating Plants in Public Buildings (Betriebsresultate und Erfahrungen bei Central Heizungsanlagen in Amtsgebäuden). Leopold Nowotny. Gives experiences and costs in four Vienna public buildings. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan 11, 1902. No. 46351 B.

Inventions.

Some Ingenious Inventions. Howard A. Coombs. Describes some simple inventions, showing great inventive ability, giving sketches. 1500 w. Am Mach—Feb. 6. 1902. No. 46095.

Kiln.

Thomson's Kiln. An illustrated description of a new kiln, with statement of the advantages claimed, and explanation of the method of working. 3000 w. Ir & Coal Trds Rev—Jan. 24, 1902. No. 45-993 A.

Plumbing.

Plumbing in the Hotel Wellington, New York. Illustrated description of hotel equipment, including 130 private bath and toilet rooms. 2700 w. Eng Rec. Feb. 1, 1902. No. 46073.

Resonance.

See Electrical Engineering, Electro-Physics.

Speed Variations.

Stroboscopic Study of the Variations in the Angular Velocity of the Fly-Wheel of an Otto Gas Engine (Etude des Variations de la Vitesse Angulaire du Volant d'une Machine a Gaz Otto a l'Aide de la Méthode Stroboscopique). A Cornu. A paper giving an account of experiments, with photographic records. 1500 w. Bull Soc Internationale d'Electriciens—Jan. 1902. No. 46398 E.

The Sartori Stroboscopic Method of Measuring the Variations in the Angular Velocity of a Machine (Sur les Procédés de Mesure de l'Ecart Angulaire d'une Machine Procédé Stroboscopique de M. Sartori). M. Blondin. A paper giving an illustrated description of an optical method, using Bedel-Moler disks, one revolved by the machine the other by a constant speed electric motor. 2000 w. Bull Soc Internationale d'Electriciens—Jan., 1902. No. 46399 E.

Standards.

The National Bureau of Standards. Samuel W. Stratton. Reviews the provisions made by Congress, and explains the duties of the National Bureau of Standards, established March 3, 1901. 4900 w. Jour Fr Inst—Feb., 1902. No. 46-034 D.

Ventilators.

High Pressure Ventilators Driven by Steam Turbines (Ventilateurs pour Hautes Pressions Mus pas Turbines à Vapeur). A. Rateau. An illustrated account of the advantages of steam turbines for driving centrifugal blowers and pumps, with results of tests. 2500 w. Génie Civil—Feb. 8, 1902. No. 46347 D.

Mechanical Ventilation. W. Yates. Read at meeting of the Brit. Inst. of Heat. & Ven. Engrs. Discusses the subject of vacuum or ventilation by extraction, and plenum, or ventilation by blowing in. Ill. 4200 w. Met Work—Feb. 22, 1902. No. 46408.

MINING AND METALLURGY

COAL AND COKE.

Australia.

The Coke Industry in Australia. A report of the various works, with general information. 4500 w. Ir & Coal Trds Rev —Feb. 7, 1902. No. 46225 A.

Coal-Cutter.

The Champion Eisenbeis Coal-Cutter. Illustrated description of a machine of the pneumatic percussive type, but differing in principle. 1000 w. Co. Guard—Feb. 7, 1902. No. 46227 A.

Coal Fields.

The Development of the Indiana County, Pa., Coal Fields. William Gilbert Irwin. A report of this field which has been greatly benefited by a recently completed railroad. 1000 w. Eng & Min Jour—Jan. 25, 1902. No. 45952.

Coal Trade.

See Industrial Economics.

Composition.

The Coking and the Composition of Coal (Betrachtungen über das Backen und

We supply copies of these articles. See page 159.

über die Bildung der Steinkohle). Prof. Ed. Donath. A discussion of the origin and composition of coal and of the theory of coking. Serial. 3 parts. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 11, 18, 25, 1902. No. 46370 each B.

Mechanical Engineering.

Mechanical Engineering as Applied to Coal Mines, and Its Relation to the Economical and Successful Operation of the Same. William Glyde Wilkins. Read before the W. Penn. Cent. Min. Inst. 4200 w. Mines & Min—Feb., 1902. No. 46142 C.

New Plant.

New Plant at Shaft No. 5 of the Spring Valley Coal Co., at Spring Valley, Ill. A. Dinsmoor. An illustrated description of the underground and surface arrangements. 3300 w. Mines & Min—Feb., 1902. No. 46141 C.

Oregon.

The Coos Bay Coal Fields. Cleveland Rockwell. Illustrates and describes this region, giving the history of these coal fields and their working. The coal is lignite. 3300 w. Eng & Min Jour—Feb. 15, 1902. No. 46264.

Production.

Coal Production Measuring Southern Advance. Edward Wheeler Parker. Reviews the history of the coal-mining industry in the South. 3200 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46419.

West Virginia.

West Virginia Coal and the World's Industry. William A. MacCorkle. Discusses the deposits of coal and the successful competitive production. 3000 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46415.

COPPER.

Copper Situation.

A Consideration of the Copper Industry from a Statistical Standpoint. Walter Renton Ingalls. A discussion of facts relating to copper so far as they are apparent, reviewing the situation since the beginning of 1901. 4000 w. Eng & Min Jour—Feb. 22, 1902. No. 46481.

Lake Superior.

Lake Superior Copper. Horace J. Stevens. Reports work that has been done and improvements contemplated for the coming year. 1400 w. Mines & Min—Feb., 1902. No. 46147 C.

Smelting.

Ancient Copper Smelting in Mexico. C. W. Pritchett. Illustrates and describes a crude copper smelting plant, showing the methods used several hundred years ago. 600 w. Eng & Min Jour—Feb. 15, 1902. No. 46267.

Lead, Copper and Zinc Smelting and Refining. Charles Kirchhoff. A summary for the United States of these industries, with explanatory remarks. 800 w. Min Rept—Jan. 23, 1902. No. 45946.

Trans-Caucasus.

The Trans-Caucasus Copper Industry. Concerning the Deposits and why the copper smelting works are so few in number. Also general information. 800 w. Engr, Lond—Feb. 7, 1902. 46244 A.

GOLD AND SILVER.

Assaying.

The New York Assay Office. An illustrated article giving information concerning this interesting office and the methods in use there. 1200 w. Sci Am—Feb. 15, 1902. No. 46204.

British Columbia.

Characteristics of the Atein Gold Field. J. C. Guillim. Describes the placer bearing streams, and the region through which they pass. Ill. 2700 w. Can Min Rev—Jan. 31, 1902. No. 46046 B.

Hydraulic Mining in Omineca District During 1901. Report for the year of this placer district, especially the operations on the Vital and Town Creek section. Ill. 1800 w. B C Min Rec—Feb., 1902. No. 46190 B.

Recent Operations in the Atein District. Mostyn Williams. Brief accounts of the operations of five companies employed in construction and equipment of hydraulic plants. Ill. 2400 w. B C Min Rec—Feb., 1902. No. 46191 B.

California.

Meadow Lake Mining District. Charles W. Raymond. Outlines the history of this district, which is very interesting, and reports that recent investigations give promise of its becoming an important producer of gold. Map. 5000 w. Min & Sci Pr—Jan. 25, 1902. No. 45904.

Colorado.

Gilpin County, Colo., Mines in 1901. Reports one of the most successful years in the history of these mines. 1000 w. Eng & Min Jour—Jan. 25, 1902. No. 45953.

The Buckhorn Mine and the San Luis Park, Colo. Arthur Lakes. Illustrates and describes peculiar formations which contain some ores and present a striking appearance. Manganese and silver ores, with a little pure gold and other metals. 1700 w. Mines & Min—Feb., 1902. No. 46151 C.

The Mining Industry of Gilpin County. An interesting account of the discovery of gold in this region. Ill. 1300 w. Min Rept—Feb. 6, 1902. No. 46138.

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Concentrates.

Realizing on Concentrates When Shipping is Impracticable. E. A. H. Tays. An account of treatment given some concentrates in Mexico and the results. Ill. 1400 w. Min & Sci Pr—Feb. 8, 1902. No. 46188.

Cyanide.

Notes on Cyanide Solutions. T. Lane Carter. Briefly describes methods used in South Africa. Eng & Min Jour—Feb. 15, 1902. No. 46263.

Dredging.

Dredging for Fine Gold in Idaho. Robert Bell. Describes methods of placer mining on the Snake River. Ill. 1800 w. Eng & Min Jour—Feb. 15, 1902. No. 46265.

Extraction.

Modern Methods of Gold Extraction. Walter E. Koch. An illustrated article discussing methods, and expressing the opinion that the cyanide process and pyritic smelting give more promise for the future than any other methods. Also discussion. 5000 w. Pro Engrs Soc of W Penn—Jan., 1902. No. 46137 D.

N. S. W. Filter-Press Practice. John W. Rock. Deals with the process of extraction of gold from auriferous slimes by means of filter presses. 1600 w. Aust Min Stand—Dec. 12, 1902. No. 45970 B.

Idaho.

The Thunder Mountain Mining District, Idaho. Walter Hovey Hill. Describes the location of this district and the different routes of travel necessary to reach the camp. Gold, silver and copper are found. Map. 600 w. Eng & Min Jour—Jan. 25, 1902. No. 45954.

Thunder Mountain and Mackay, Idaho. Robert Bell. Describes the principal mineral features of this region, principally gold and copper, the routes, railways, &c., and the already developed properties. 3500 w. Min & Sci Pr—Feb. 1, 1902. No. 46051.

Macedonia.

The Gold Mines of Philip of Macedonia. J. E. Spurr. An illustrated account of these interesting placers. 1700 w. Eng & Min Jour—Feb. 22, 1902. No. 46480.

Mexico.

The Etzatlan Mining District, Mexico. E. B. Van Osdel. Describes a newly developed silver and copper district. Ill. 1000 w. Eng & Min Jour—Feb. 15, 1902. No. 46266.

The Mining District of Guanajuato, Mexico. A condensed account of historical, political and statistical matters that affect the standing of this gold and silver mining district. Ill. 6000 w. Eng & Min Jour—Feb. 8, 1902. No. 46103.

Nicaragua.

Mining in Eastern Nicaragua. J. D. Lowry. A description of an out-of-the-way gold region, its people, and resources. 2200 w. Mines & Min—Feb., 1902. No. 46150 C.

Placers.

The Upland Placers of La Cienega, Sonora, Mexico. Robert T. Hill. An illustrated description of these rich placers, and the conditions and inhabitants of this region. 2000 w. Eng & Min Jour—Jan. 25, 1902. No. 45951.

Refractory Ores.

Treatment of Refractory Silver and Gold Ores at the Mine. R. C. Campbell-Johnson. Describes the ores of British Columbia and discusses their treatment, and economical working. 1200 w. Min & Sci Pr—Feb. 1, 1902. No. 46049.

Victoria.

The Walhalla (V.) Goldfield. H. Herman. A digest of a recent report on this goldfield, submitted to the Victorian Secretary for Mines. Ill. 2500 w. Aust Min Stand—Dec. 19, 1901. Serial. 1st part. No. 45907 B.

Yukon.

White Horse Mining District, Yukon Territory. William M. Brewer. A description of the district with illustrations. 4000 w. Eng & Min Jour—Feb. 1, 1902. No. 46041.

IRON AND STEEL.

Blast Furnaces.

Blast Furnace Dimensions (Einiges über das Hochofenprofil). F. Stille. From *Werml. Annaler.* Notes on blast-furnace practice in Sweden, principally with charcoal fuel. 800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 4, 1902. No. 46368 B.

The Height of Blast Furnaces. F. L. Grammer. A discussion of this subject with the conclusion that high furnaces have been overestimated and have had their day. 2000 w. Ir Trd Rev—Feb. 20, 1902. No. 46471.

Blast Furnace Gas.

See Gas Engineering.

Cuba.

Cuban Iron. Editorial on the supplies of iron and manganese that the United States obtains from Cuba. 1100 w. Engng —Feb. 14, 1902. No. 46456 A.

Development.

Iron and Steel at the Close of the Nineteenth Century. James M. Swank. Extract from Mineral Resources of the United States, 1900. An account of the development and increase of production. 2200 w. Mines & Min—Feb., 1902. No. 46143 C.

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Germany.

See Industrial Economy.

Iowa.

Iowa's Iron Mine. S. W. Beyer. Describes Iron Hill and its deposits, discussing the nature and origin of the ore, and the outlook for the industry. 2000 w. Eng & Min Jour—Feb. 22, 1902. No. 46482.

Iron Trade.

Some Features of the Continental Iron Trade. Largely a review of the German trade during 1901, with tabulated information of the iron and steel exported from Germany to other countries. 1300 w. Ir & Coal Trds Rev—Feb. 14, 1902. No. 46450 A.

Lake Superior.

Lake Superior Ore Output. Editorial giving information concerning the wealth of iron ore from this region. 2000 w. Engng—Feb. 7, 1902. No. 46235 A.

Liquid Fuel.

Russian Open-Hearth Furnaces with Oil Fuel (Der Russische Martinofen mit Erdölfeuerung). Adrian Byström. From *Jernkontorets Annaler*. Illustrated description of apparatus for using liquid fuel in Martin open-hearth furnaces. 900 w. Oesterr Zeitschr f Berg n Hüttenwesen—Jan. 18, 1902. No. 46371 B.

New Jersey.

The Revival of Iron Mining in New Jersey. F. W. E. Mindermann. Reports the working of the Wharton and other mines with improved appliances, giving the yield of the mines now being worked. 1100 w. Eng & Min Jour—Jan. 25, 1902. No. 45955.

Rolling Mill.

New Carnegie Plate Mill at Homestead, Pa. (Neue Blechwalzwerksanlage der Carnegie Steel Co. in Homestead, Pa.). Hermann Jelies. An addition to a previous article on "American Rolling Mills," giving an illustrated description of these works, in which a practically new plant of the Bethlehem Co. was used. 1 plate. 700 w. Stahl u Eisen—Feb. 1, 1902. No. 46-338 D.

Steel Corporation.

See Industrial Economics.

Steel Works.

The Cambria Steel Company's New Works. Illustrated description of recent improvements in these works at Johnstown, Pa. 2500 w. Ir Age—Feb. 6, 1902. No. 46100.

Tennessee.

The Smith Mine, Tennessee. N. W. Buckhout. The location and quality of the ores, which are limonite, or brown ore, and the methods of mining, cleaning, and handling them are described. 2200 w. Mines & Min—Feb., 1902. No. 46146 C.

Wyoming.

The Sunrise Iron Mines in Wyoming. John Birkinbine. Illustrations with brief description. 1600 w. Ir Age—Feb. 6, 1902. No. 46102.

MINING.

Barometer.

The Barometer in Mining. F. Z. Schellenberg. Read before the W. Penn. Cent. Min. Inst. Discusses the possibilities and importance of the use of this instrument in guarding against gas in mines. 1000 w. Mines & Min—Feb., 1902. No. 46149 C.

Drowned Workings.

Tapping Drowned Workings. W. B. Wilson, Jr. Abstract of a paper and the discussion before the N. of Eng. Inst. of Min. & Mech. Engrs. Describes the tapping at Wheatley Hill Colliery. The workings were those of Thornley Colliery, which, owing to a fire in 1858, it had been found necessary to drown out. 3000 w. Col Guard—Feb. 14, 1902. No. 46451 A.

Explosion.

Notes on the Llanbradach Explosion. A review of the report on this disaster, which occurred Sept. 10, 1901. 1800 w. Col Guard—Feb. 14, 1902. No. 46453 A.

The Llanbradach Colliery Explosion. Official report, by J. S. Martin, on the circumstances attending an explosion near Cardiff, on Sept. 10, 1901. 2800 w. Col Guard—Jan. 24, 1902. No. 45979 A.

The Talk o'-th'-Hill Colliery Explosion. Official report by W. N. Atkinson, H. M. inspector of mines, on the circumstances attending the accident. Ill. 5500 w. Col Guard—Jan. 31, 1902. No. 46127 A.

Explosives.

Government Explosives and Safety Appliances in the Wilczek Mines at Polnisch-Ostrau, Austria (Ueber die Anwendung ärarischer Spengmittel und einiger Sicherheits und Sanitätsbehelfe beim Gräflich Wilczek 'schen Bergbau in Polnisch-Ostrau). Josef Mauerhofer. An illustrated account of experiences with dynammon, a government safety explosive, and of safety and sanitary arrangements at these coal mines. Serial. 3 parts. 3 plates. 7000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 4, 11, 18, 1902. No. 46367 each B.

Freezing Process.

Shaft Sinking by the Freezing Process (Les Nouveaux Fonçages par Congélation). H. Schmerber. An illustrated description of shaft sinking at two French mines and at the Ronnenberg Alkali Works, Hanover. Serial. 3 parts. 6000 w. Génie Civil—Jan. 18, 25, Feb. 1, 1902. No. 46341 each D.

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Geology.

Mining Geology. G. J. Binns. Lecture delivered before the South Midland Branch of the Coal Managers' Assn. Discusses geology especially in its relation to coal fields. 6300 w. N Z Mines Rec—Dec. 16, 1901. No. 45967 B.

Grades.

Mine Grades. A. W. Warwick. Considers some of the principles affecting mine grades, and the conditions upon which the choice depends. 2100 w. Min Rept—Feb. 6, 1902. No. 46139.

Jig.

A Single Track Mining Jig. Sketches and description of a single track gravity tramway that has been in successful operation at the Gold Hill Mine, Grass Valley, California. 1200 w. Min & Sci Pr—Feb. 8, 1902. No. 46189.

Mining Plant.

See Electrical Engineering, Power Applications.

Ores.

Variation of Ores in Depth. Dr. J. W. Gregory. Lecture on the factors that control the variation. 4300 w. Aust Min Stand—Dec. 19, 1901. Serial. 1st part. No. 45908 B.

Underground Transportation.

Transportation of Material Underground. A. W. Warwick. As an example, the working of a small low grade mine is considered. The present article deals principally with the financial side. 2700 w. Min Rept—Jan. 30, 1902. Serial. 1st part. No. 46045.

Water Problem.

The Water Problem in Cripple Creek and Other Colorado Camps. Arthur Lakes. A statement of the cause, and the methods used in freeing the mines from water. 3000 w. Mines & Min—Feb., 1902. No. 46145 C.

Winding Engines.

Schlüter's Safety Appliances for Winding Engines. Illustrated description. 600 w. Col Guard—Feb. 7, 1902. No. 46228 A.

MISCELLANY.

Briquetting.

The Briquetting of Fuels and Fine Mineral Ores. Wm. Gilbert Irwin. A review of the development of briquetting methods and machinery, with some account of their applications in the United States. 4000 w. Engineering Magazine—March, 1902. No. 46388 B.

Deposits.

Ore Deposits. F. Danvers-Power. The present article reviews the "nebular hypothesis" as explanatory to the origin of ores. 3000 w. Aust Min Stand—Jan. 16, 1902. Serial. 1st part. No. 46441 B.

Hungary.

Mining and Metallurgy in Hungary, in 1900 (Ungarns Berg und Huttenwesen 1900). From *Bány. és Koh. lapok.* General statistics. Serial. 3 parts. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 4, 11, 18, 1902. No. 46369 each B.

Lead.

Lead Smelting in Southeast Missouri. R. B. Brinsmade. A description of the different methods used, and the advantages and disadvantages of each. Ill. 1600 w. Mines & Min—Feb., 1902. No. 46144 C.

Metal Statistics.

Metal Statistics for 1898 (Recueil Statistique des Petits Métaux Pendant l'Année 1898). An abstract of statistics published by the Metal Gesellschaft and the Metallurgische Gesellschaft, of Germany, giving production, prices, etc., of lead, copper, zinc, tin, nickel, aluminum, mercury and silver in various countries. 2500 w. Revue Technique—Jan. 25, 1902. No. 46366 D.

Petroleum.

Import of the Production of Southern Petroleum. F. H. Oliphant. Reviews the production in West Virginia, Texas, Kentucky and Tennessee, describing the character of the oil and giving related information. 3500 w. Mfrs Rec—Feb. 22, 1902. Special number. No. 46421.

The Chemical Analysis of Crude Petroleum and Oil Rock. Dr. J. Ohly. Explanatory of method of analysis used. 2200 w. Min Rept—Feb. 20, 1902. Serial. 1st part. No. 46465.

The Colorado Oil Industry. A report of conditions in this state, the processes and products, their use, &c., with brief notices of recently incorporated companies. 2500 w. Min Rept—Jan. 30, 1902. No. 46044.

Southern Petroleum and the Fuel Market. C. F. Z. Caracristi. A review of the petroleum development in the south, its values as compared with coal at present prices, and as a fuel. 3800 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46416.

Phosphate.

Progress in the Southern Phosphate Belt. Hugh Wiley. Historical review of the phosphate mining industry, and the location of the southern deposits. 2000 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46422.

Platinum.

The Platinum Metals. Notes where deposits are found, and the properties of platinum metals in the present article. 2400 w. Aust Min Stand—Jan. 16, 1902. Serial. 1st part. No. 46440 B.

We supply copies of these articles. See page 159.

Prussia.

The Production of Prussian Mines, Salt Works and Metallurgical Works in 1900 (Die Production der Bergwerke, Salinen und Hütten des Preussischen Staates im Jahre 1900). General statistical tables. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 25, 1902. No. 46373 B.

Quarries.

Excavating Machinery for Quarry Use. An illustrated article giving particulars of the working of a steam navvy or excavator taken from a paper read by A. L. Stevenson, before the North of England Inst. of Min. & Mech. Engrs. 3000 w. Quarry—Feb. 1, 1902. No. 46209 A.

Irish Stone Quarries. A review of the quarries of limestone, marble and building stones. 3000 w. Quarry—Feb. 1, 1902. No. 46210 A.

The Stone Mining Industry in Greece. A. Cordella, in *Zeitschrift für das Berg-, Hutten-, und Salinenwesen.* Report of the mines of emery, magnesite, meerschaum, millstones, gypsum, marble, and various other deposits. 5000 w. Quarry—Feb. 1, 1902. No. 46211 A.

Southern Minerals.

Development of the Mineral Resources of the South. David T. Day. Explains how much is included in "the south," and reviews the developments. 3200 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46420.

Tin.

An Occurrence of Stream Tin in the York Region, Alaska. Alfred H. Brooks. From Mineral Resources of the U. S. Geol. Survey. A description of the deposit, which is of scientific rather than commercial interest. 1700 w. Min Rept—Feb. 13, 1902. No. 46272.

Australian Tin and Tin Mining. John Plummer. Information concerning the location of these deposits, and the extent to which they have been worked. 900 w. Ir Age—Feb. 6, 1902. No. 46099.

The Mining in Malaya. Discusses the tin deposits in the Malay Peninsula, and the future outlook as a tin-producing region. 1400 w. Aust Min Stand—Dec. 26, 1901. Serial. 1st part. No. 45905 B.

Tungsten.

Tungsten. G. M. Parker. A description of methods of tungsten determination, as given in a recent graduation thesis. 1600 w. Aust Min Stand—Jan. 2, 1902. No. 46438 B.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Investigation of the Park Ave. Tunnel Collision. Report of testimony. 3000 w. Eng News—Jan. 30, 1902. No. 45916.

Report of the New York State Railroad Commission on the Park Avenue Tunnel Collision. Extracts from the report dealing with methods of improvement, with editorial discussion of the problem of tunnel ventilation. 7400 w. Eng News—Feb. 13, 1902. No. 46195.

The New York Tunnel Collision. Editorial discussion of this recent disaster. 1200 w. Loc Engng—Feb., 1902. No. 45940 C.

The Safety of Trains in the Fourth Avenue Tunnel—The Commissioners' Preliminary Order. Editorial discussion of the recommendations, and of the conditions. Also discusses the report on the collision. 3000 w. R R Gaz—Feb. 14, 1902. No. 46200.

Train Accidents in the United States in December. A condensed record of the principal accidents with editorial comments on the most serious. 5500 w. R R Gaz—Jan. 31, 1902. No. 46057.

Block System.

Kinsman Block System for Control of Railway Trains. Illustrated description. 1000 w. Elec Wld & Engr—Feb. 15, 1902. No. 46296.

Car Famines.

How to Prevent Car Famines. W. L. Surran. A letter giving suggestions that the writer thinks will alleviate if it does not remedy. 1800 w. Ry Age—Feb. 14, 1902. No. 46270.

Promptness.

What Can We Do Toward Getting Trains Over the Road with More Promptness? Eugene McAuliffe. States familiar troubles and offers some suggestions for remedying them. 1700 w. St. Louis Ry Club—Jan. 10, 1902. No. 46032.

Train Service.

British and French Train Services in 1901. Charles Rous-Marten. A review of the principal train services of Great Britain and France as scheduled in the official time-books during the first year of the twentieth century. 2700 w. Engr, Lond—Feb. 14, 1902. Serial. 1st part. No. 46458 A.

Transvaal.

The Railway Reorganization of the Transvaal. A. Cooper Key. A review of the former railway systems, and a critical examination of the conditions under which operations may be successfully re-established. 2500 w. Engineering Magazine—March, 1902. No. 46386 B.

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MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Test of an Automatic Air-Safety Valve by the Pennsylvania Lines. Illustrated report of a test of a recently devised mechanism for attachment in connection with existing air-brake systems. The invention of F. B. Morrison. 700 w. Ry & Engng Rev—Feb. 15, 1902. No. 46277.

Bolsters.

New Construction of Steel Center Sills and Bolsters. Illustrates the arrangement employed in recent cars of the Chicago, Milwaukee and St. Paul Railway. 400 w. Am Engr & R R Jour—Feb., 1902. No. 46066 C.

The Bolster Problem. R. P. Lamont. Presents points, mainly from the standpoint of the manufacturer, giving also information of a large number of cars. Followed by general discussion. 11000 w. W Ry Club—Jan. 21, 1902. No. 46251 C.

Buffer.

Through Buffer Rods for Cars (Durchgehende Stossvorrichtung für Eisenbahnfahrzeuge). Ludwig Ritter v. Stockert. An illustrated description of the Alma-Weiss system of double buffers, in which the rods extend right through under the car and powerful springs under the center of the cars take up shocks. Record of tests. 1 plate. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 25, 1902. No. 46356 B.

Cars.

Box Car, 80,000 Pounds Capacity. Drawings illustrating a new box car with wooden sills and metal bolsters, built for the Chesapeake & Ohio. 350 w. Am Engr & R R Jour—Feb., 1902. No. 46061 C.

Hocking Valley Ry. 30-Ton Side Dump Car with Steel Box. Illustrated description. 1000 w Ry & Engng Rev—Feb. 1, 1902. No. 46058.

60,000-Lbs. Capacity Stock Car, Illinois Central R. R. Detailed drawings, with description. 700 w. Ry & Engng Rev—Feb. 8, 1902. No. 46177.

Thirty-six Foot 60,000-lb. Capacity Box Cars, Delaware, Lackawanna and Western. Plans and brief description of design of which 1000 cars were recently ordered. 400 w. Ry Mas Mech—Feb., 1902. No. 45974.

Conveyor.

Cinder Pit Conveyor. An illustrated description of a device that has proved a great money-saver. 500 w. Ry Mas Mech—Feb., 1902. No. 45975.

Couplers.

I. Improvements in Car Couplers and Draft Rigging. II. Flexibility in Car Coupling Attachments. Two articles discussing recent papers before the railway clubs. 6000 w. Ill. Eng News—Jan. 30, 1902. No. 45913.

Flanges.

Standardization of Extra Heavy Flanges. A committee report of the recommendations and schedule for standard at a meeting held in New York City, June 28, 1901. 900 w. Stevens Ind—Jan., 1902. No. 45934 D.

Flue Rattler.

New Flue Rattler. Illustrates and describes a novel rattler which is giving good results in the boiler plant of the Chicago and Northwestern Railway at West Chicago. 500 w. Am Engr & R R Jour—Feb., 1902. No. 46062 C.

Locomotives.

Comparing Heavy and Light Locomotives. Edward Grafstrom. Comments on recent road tests made, and the lessons from them. Favors moderating the size of engines to suit the traffic demands. 1000 w. Am Engr & R R Jour—Feb., 1902. No. 46067 C.

Compound Consolidation Locomotive, M. St. Paul & S. Ste. M. Ry. Illustration, noting important features, of one of four recently built engines. 900 w. Ry & Engng Rev—Feb. 15, 1902. No. 46274.

Compound Consolidation Passenger Locomotive. Illustrated description of a locomotive used on grades of 3 and 4 per cent., and curves of 16 degrees in the mountains of Colorado. 600 w. Am Engr & R R Jour—Feb., 1902. No. 46064 C.

Compound Tank Locomotive, Indian Netherlands Railway, Java. Sectional drawings with brief note. 180 w. Engr, Lond—Feb. 14, 1902. No. 46462 A.

Egyptian Experimental Locomotives. Illustrates and describes six striking examples of modern locomotive engineering, two British and four American built. 1200 w. Engr, Lond—Feb 7, 1902. No. 46242A.

Heavy Locomotives. Discussing the present tendency, and whether it is justified, and related questions in transportation. 2200 w. Am Engr & R R Jour—Feb., 1902. No. 46065 C.

Locomotive Building in the United States. Fred H. Colvin. A collection of notes from various sources giving information concerning locomotive works that have been in existence. 2000w. Loc Engng—Feb., 1902. Serial. 1st part. No. 45937 C.

Mathias Baldwin and the American Locomotive. Editorial review of the Baldwin Locomotive Works of Philadelphia, which have reached their seventieth anniversary as an industry, and completed their twenty-thousandth locomotive. 1700 w. Ir Age—Feb. 20, 1902. No. 46400.

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Representative American Locomotive Exhibits. William B. Aiken. A comparison of the exhibits made at various American expositions during the last twenty-five years. 1000 w. Loc Engng—Feb., 1902. No. 45939 C.

Six-Coupled Express Locomotive, Eastern Railway of France. Illustrated description of a locomotive representative of recent French practice. 2000 w. Engr, Lond—Jan. 24, 1902. No. 45989 A.

Tandem Compound Decapod for the Santa Fe. Illustrated detailed description of the heaviest locomotives ever built up to the present time Oil is the principal fuel used. 2000 w Ry Age—Jan. 31, 1902. No. 46054.

Thomas & Stetson Oil Burning Locomotive. An illustrated description of a new style boiler for locomotives burning oil as fuel. 600 w. Loc Engng—Feb., 1902. No. 45936 C.

Motive Power.

The Proper Utilization of Motive Power. T. M. R. Talcott. Condensed from a paper presented at meeting of the Southern & Southwestern Ry. Club. Generally favorable to pooling or double crewing locomotives. 2800 w. Ry & Engng Rev—Feb. 8, 1902. No. 46178.

Snow Plow.

Self-Turning Snow Plow on the Delaware, Lackawanna & Western R. R. Illustrates and describes a car with a self-contained turntable arrangement for turning the plow end for end at any point without having to use a stationary turntable. 5000 w. Ry & Engng Rev—Feb. 22, 1902. No. 46477.

Steam Motor Cars.

Steam Motor Cars for Railway Service. An illustrated account of some experiments undertaken a few years ago with steam motor cars for railway service, with disappointing results. Also editorial discussion of some of the reasons of their failure, and of the great field awaiting a successful independent motor car. 7500 w. Eng News—Feb. 6, 1902. No. 46104.

Steel Cars.

Shop Practice in Maintenance of All-Steel Cars. Report of committee with general discussion. 5000 w. Cent Ry Club —Jan., 1902. No. 46135 C.

Superheated Steam.

See Mechanical Engineering, Steam Engineering.

Valves.

By-Pass and Starting Valves A. T. & S. F. Four Cylinder Tandem Compound. Illustrated description. 700 w. Ry Age—Feb. 14, 1902. No. 46271.

NEW PROJECTS.

Ship Railway.

An Isthmian Ship Railway. A. E. Cheff. Gives designs of the Eads ship-railway proposed, and discusses the Tehuantepec route, and the practicability of the scheme. 1200 w. Sci Am Sup—Feb. 15, 1902. No. 46206.

Victoria Nyanza.

To the Victoria Nyanza by the Uganda Railway. Commander B. Whitehouse. A paper containing much information of the railway, the survey of the future port, &c. Also discussion. 9800 w. Jour Soc of Arts—Feb. 14, 1902. No. 46409 A.

PERMANENT WAY AND FIXTURES.

Bern-Neufchatel.

The Bern-Neufchâtel Railway (Die Bern-Neuenburg Bahn). Albin Beyeler. An illustrated general account of the new direct line between these Swiss cities, with descriptions of bridges and construction work. Serial. 2 parts. 5000 w. Schweiz Bauzeitung—Jan. 4, 11, 1902. No. 46374 each B.

Canadian Railway.

The Construction of the Great Northern Railway of Canada, 1899-1900. J. M. Shanly. Interesting account of the undertaking with description of the work. 3 plates. 4800 w. Can Soc of Civ Engrs—Adv. proof.—Feb., 1902. No. 46250 D.

Crossing Gates.

Some Features of Crossing Gate Operation. Illustrates and describes features of the pneumatic gates of the Bogue and Mills system. 1000 w. Ry & Engng Rev —Feb. 1, 1902. No. 46059.

Curves.

Slide Rule Computations for Laying Out Curves. Henry T. Stiff. Briefly explains how the slide rule may be used with accuracy and a great saving of time. 900 w. Eng News—Feb. 20, 1902. No. 46489.

Dutch East Indies.

The Railways of the Dutch East Indies (Les Chemins de Fer aux Indes Nerlandaises). Auguste Moreau. A comprehensive account of the railways and tramways of Java, Madura and Sumatra, and their construction and operation. Maps. 9000 w. Mem d l Soc d Ing Civils de France—Dec., 1901. No. 46377 G.

Grade Crossings.

Abolition of Grade Crossings. Charles Zueblin. An illustrated article reviewing what has been accomplished and what should be done in various cities of the United States. 3200 w. Munic Af—Dec., 1901. No. 46297 D.

New York Terminal.

New York Central Underground Passenger Loop. Plan with brief description.

We supply copies of these articles. See page 159.

Also recommendations of the New York Railroad Commissioners concerning the movement of trains, &c. 1100 w. Ry Age—Jan. 31, 1902. No. 46052.

The Proposed Tunnel Loop at the Grand Central Station. Plan showing the arrangement proposed with explanatory notes. 700 w. R R Gaz—Jan. 31, 1902. No. 46055.

Paris.

The New Paris Terminal of the Orleans Railway (Prolongement de la Ligne d'Orléans dans Paris). A Dumas. A very well illustrated description of the underground extension of the Orleans Ry. along the left bank of the Seine, and of the magnificent station on the Quai d'Orsay and its mechanical equipment. 1 plate. 1200 w. Génie Civil—Jan. 25, 1902. No. 46342 D.

Railway Improvements.

The Cincinnati Southern Ry. and Its Improvements. History, with general description of the original combination of this municipally owned line, its recent improvements, operation, equipment, &c. Ill. 6500 w. Eng News—Feb. 20, 1902. No. 46487.

Shops.

Erie Railroad Shops, Dunmore, Pa. Plan and front elevation, with description of shops representing the best modern practice. Gives also a list of tools and motors used. 3000 w. Loc Engng—Feb., 1902. No. 45938 C.

Rock Island Shop Improvements at Chicago. Information concerning recent changes made necessary by the increase in traffic. 900 w. Ry Age—Jan. 31, 1902. No. 46053.

Signalling.

Interlocking Signalling. W. H. Patton. Read before the Engrs. Club of Toronto. Describes some signals now in use, showing their importance, and reviews various forms and the development of the interlocking system. 2500 w. Can Engr—Feb., 1902. No. 45972.

Railway Signalling. Describes a system that has been experimented upon in France, by which a signal disc and alarm bell inside the cab are electrically operated when the engine runs accidentally past a danger signal. 1300 w. Engng—Feb. 7, 1902. No. 46232 A.

Track Elevation.

Track Elevation on the New York, New Haven & Hartford R. R. at Boston, Mass. Illustrations, plans and description of work to eliminate a number of grade highway crossings where condensed traffic had to be protected. 7700 w. Ry & Engng Rev—Feb. 1, 1902. No. 46060.

Tracks.

Construction Work on the Aurora, Elgin & Chicago Railway. An illustrated account of probably the best example of heavy high-speed electric railway work now to be found. 1400 w. St Ry Jour—Feb., 1902. No. 46083 D.

TRAFFIC.

Progress.

Community of Interest from a Traffic Standpoint. B. D. Caldwell. An interesting address on the progress we may look for in this new century, and its application to the community of interest in railroading. Discusses some of the principles essential. General discussion. 16000 w. N. Y. R R Club—Jan. 16, 1902. No. 46253.

Report

Annual Report of the Interstate Commerce Commission. Extracts concerning packing-house products, rates, traffic associations, safety appliances, &c. 4500 w. R R Gaz—Jan. 31, 1902. No. 46056.

Ton-Mile.

The Ton-Mile in India. Notes by Lieut.-Gen. Sir Richard Strachey stating the reasons which led to the adoption of ton and passenger mileage returns, more than 30 years ago, under the orders of the Governmen of India, and the results which have followed. 1800 w. Transport—Jan. 31, 1902. No. 46116 A.

Tonnage

Handling Less Car Load Tonnage. Edwin H. Lea. Discusses the causes of the irregularities that lead to losses in the payment of damage claims, and the remedies. 1100 w. R R Gaz—Feb. 14, 1902. No. 46199.

Tonnage Rating on Railways. J. W. Harkom. Describes methods of rating locomotives in use on the Canadian Pacific Railway. 2000 w. Am Engr & R R Jour—Feb., 1902. No. 46063 C.

Train Tonnage. Henry Miller. Discusses, in a general way, how to properly and economically load and operate trains. 1000 w. St. Louis Ry Club—Jan. 10, 1902. No. 46031.

MISCELLANY.

Comparison.

Railways: British and American. A. H. Tatlow, in the *Railway Official Gazette*. A comparison of cost, mileages, construction and equipment, traffic returns, &c., giving much information of interest. 2000 w. Ry & Engng Rev—Feb. 15, 1902. No. 46278.

Education

See Industrial Economy.

Government Ownership.

Government Ownership of Railroads. Hon. Martin A. Knapp. Extracts from an article in the *Annals of the American Acadamy, &c.* Outlines some of the arguments for and against the public owner-

We supply copies of these articles. See page 159.

ship of railroads. 3000 w. Ry & Engng Rev—Feb. 15, 1902. No. 46276.

Great Britain

Light Railroads in Great Britain. C. H. Grinling. States what led to the passing of the Light Railways Act of 1896, its object, and the power of the Board of Trade over this class of railways. 1300 w. R R Gaz—Feb. 7, 1902. No. 46115.

Interstate Commerce

The Interstate Commerce Law. Editorial discussion of the Elkins bill to enlarge the powers of the Interstate Commerce Commission. 2000 w. R R Gaz—Feb. 14, 1902. No. 46201.

Railroad Development.

Phases of Southern Railroad Development, 1881-1901. John P. Meany. Historical review. 5400 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46418.

Siam

Railways in Siam. Gives briefly the history of railroads in this country, and their present condition. 1400 w. U S Cons Repts, No. 1272—Feb. 21, 1902. No. 46407 D.

STREET AND ELECTRIC RAILWAYS

Accidents.

Accidents to Tramway Passengers from Contributory Negligence. J. Neville Porter. Discusses the legal aspects of the question of compensation for personal injuries. 2800 w. Tram & Ry Wld—Jan. 9, 1902. Serial. 1st part. No. 46006 B.

Berlin.

The Electric Elevated and Underground Railway in Berlin (Die Elektrische Hoch- und Untergrundbahn in Berlin). Hr. Frahm. A well illustrated description, particularly of the elevated structure and details of construction. 3500 w. Stahl u Eisen—Feb. 1, 1902. No. 46337 D.

Brakes.

The Price Friction Brake. Illustrated detailed description of a device for tramcars operated by the energy of the moving car, and claiming many advantages. 1100 w. Tram & Ry Wld—Jan. 9, 1902. No. 46005 B.

Brighton.

Brighton Corporation Electric Tramways. Illustrated detailed description of the tramway system of Brighton, England. 1800 w. Elec Rev, Lond—Jan. 24, 1902. No. 45996 A.

Car Equipments

Electric Car Equipments and Their Maintenance. A. W. Wigram. Abstract of paper read before the Newcastle Sec. of the Inst. of Elec. Engrs. Discusses tracks, brakes, life guards, motor equipment, trolley heads, controllers, &c. 4000 w. Elect'n, Lond—Jan. 24, 1902. No. 45998 A.

Car House.

Car House at Worcester, Mass. Brief description with plan and diagram. 700 w. St Ry Rev—Feb. 15, 1902. No. 46281 C.

Dangers.

The Supposed Dangers of Electric Traction. Editorial discussion of the recently published letter from Mr. George Westinghouse. 1100 w. Sci Am—Feb. 1, 1902. No. 45957.

Electric Railways.

Electricity for the New York Central Tunnel. Frank J. Sprague. A reply to the letters of Mr. George Westinghouse on the subject of the dangers of electric traction in tunnels. 1500 w. Elec Wld & Engr—Feb. 1, 1902. No. 46014.

The Rise of Electric Railways in Massachusetts. Alton D. Adams. A review showing remarkable development and financial expansion. 3000 w. Elec Rev, N. Y—Feb. 8, 1902. No. 46160.

Some Personal Notes on Electric Railways. Frank J. Sprague. Interesting notes relating to the Union City Railway of Richmond, 1887, and the South Side Elevated of Chicago, 1897. 2800 w. Elec Rev, N. Y—Feb. 15, 1902. No. 46287.

Express Business.

Handling Express Matter in Electric Cars in New York. Information concerning the methods adopted for carrying on the details of the express, freight and baggage service in special express cars of the Metropolitan St. Ry. system of New York, including the Union Ry. lines in the Bronx. Ill. 1700 w. St Ry Rev—Feb. 15, 1902. No. 46280 C.

Fenders.

Street Car Fenders (Schutzvorrichtungen an Strassenbahnwagen). M. Kosch. An illustrated description of various kinds of fenders for picking up people falling in front of street cars. 3000 w. Elektrotech Zeitschr—Jan. 30, 1902. No. 46326 B.

Germany.

Experiments with Electric Traction on Standard Railways in Germany (Versuche über Elektrischen Betrieb auf einigen Hauptbahnen in Deutschland). Ludwig Spängler. A well illustrated account of some of the electric railways in successful operation, and particularly of recent high-voltage and high-speed experiments on the Wannsee Ry., at Lichterfelde and on the Zossen Ry. Serial. 2 parts. 10,000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 17, 24, 1902. No. 46358 each B.

We supply copies of these articles. See page 159.

High Speed.

High-Speed German Railway at Zossen. Frank C. Perkins. Illustrations and description of the car equipment for the high-speed, polyphase railway experiments, where more than 100 miles an hour has been attained. 1500 w. Sci Am—Feb. 8, 1902. No. 46088.

Modern Fast Trains (Moderne Schnellzüge). A short review of high-speed train records and of electric high-speed projects. 1200 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 11, 1902. No. 46353 B.

Interurban.

The Hartford and Springfield Street Railway. Illustrates and describes a line that forms an important link in connecting New York and Boston by trolley. 1500 w. St Ry Jour—Feb. 1, 1902. No. 46081 D.

The Lansing, St. John & St. Louis Electric Ry. An illustrated account of the opening of a new electric interurban road for passenger and freight traffic, in Michigan. 1400 w. Ry & Engng Rev—Feb. 15, 1902. No. 46275.

Lifts

The Electric Lifts of the City and South London Railway. Illustrated detailed description of the satisfactory apparatus at the stations for the use of passengers. 1800 w. Tram & Ry Wld—Jan. 9, 1902. No. 46004 B.

Mails.

Mail Transportation in Cities. Waldon Fawcett. An illustrated article on the recent improvements made, by the establishing of sub-stations for postal distribution, electric cars, pneumatic tubes, and automobiles for transportation, &c. 1000 w. Sci Am—Feb. 15, 1902. No. 46202.

Newcastle-on-Tyne.

The Electric Tramways of Newcastle-on-Tyne. Illustrated description with account of some of the difficulties attending the work of construction. 4500 w. Tram & Ry Wld—Jan. 9, 1902. No. 46003 B.

New York.

The New York Rapid Transit Railway. This first article of a series reviews the early history of rapid transit enterprises in New York city. 5000 w. Eng News—Jan. 30, 1902. No. 45911.

New York Elevated R. R.

Electrical Equipment of the Manhattan Railway. Brief description with illustrations of the largest electrical plant yet built in the United States. 1400 w. St Ry Rev—Feb. 15, 1902. No. 46282 C.

Electricity on New York's Elevated Railways. Hermann A. Strauss. Outlines the plan of power supply giving illustrations. 3300 w. Elec Age—Jan., 1902. No. 46022 C.

Power System and Generating Station of the Manhattan Railway Co., New York. Arthur L. Rice. An illustrated detailed description of the power station, boiler plant, feed water system, steam piping, engines, exhaust system, etc. 10500 w. Engr, U S A—Feb. 1, 1902. No. 46047.

New Power Station of the Manhattan Railway Company. Illustrations and descriptive notes on the engines and generators of the electrical system being installed on the Manhattan Elevated Railway, in New York. 2000 w. St Ry Jour—Feb. 1, 1902. No. 46080 D.

Some Features of the Manhattan Elevated Railroad Company's Station Equipment. Illustrated description. 2500 w. Am Elect'n—Feb., 1902. No. 46028.

Park.

An Attractive New England Street Railway Park. H. S. Knowlton. Illustrated description of the park at Whalom Lake, belonging to the Fitchburg & Leominster Street Railway Co. 2500 w. St Ry Jour—Feb., 1902. No. 46084 D.

Pittsfield, Mass

New High Alternating Current Installation of the Berkshire Street Railway Co., at Pittsfield, Mass. Illustrated description of a route through western Massachusetts, a region renowned for its beauty. The powerhouse, sub-stations, overhead construction, and equipment are described. 2200 w. St Ry Rev—Feb. 15, 1902. No. 46279 C.

Storage Batteries

See Electrical Engineering, Generating Stations.

Stray Currents.

The Path of the Return Currents in Electric Street Railways and their Electrolytic Action (Ueber den Verlauf der Rückströme von Strassenbahnen und über ihre Elektrolytischen Wirkungen). Illustrated abstract of a paper by M. G. Claude before the Paris Electrical Congress, giving the results of experiments, with recommendations. 2000 w. Elektrotech Zeitschr—Jan. 23, 1902. No. 46324 B.

See also Electrical Engineering, Communication.

Surface-Contact.

The Lorain Surface Contact System. Illustrated detailed description of the equipment of the Wolverhampton Corporation tramways. 2500 w. Elec Engr, Lond—Feb. 7, 1902. No. 46218 A.

Tracks.

Progress in Street Railway Track Construction. Charles S. Butts. Reviews the methods of track construction in early days of street railroading, and describes the most approved modern practice. 2500 w. St Ry Jour—Feb. 1, 1902. No. 46082 D.

We supply copies of these articles. See page 159.

EXPLANATORY NOTE.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.;-F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Age. *m.* *New York.*
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical Times. *w.* London.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.

Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

IMPROVED MACHINERY

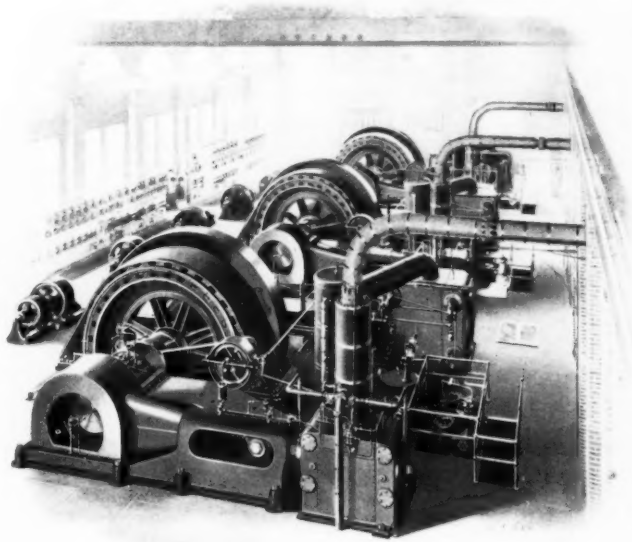
New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

A Notable Power Plant.

THE accompanying illustration shows the power plant of the Union Traction Co., of Anderson, Indiana. The three engines shown are the Rice & Sargent pattern made by the Providence Engineering Works, of Providence. In addition to the size and general efficiency of the engines, it was a requirement that they should run in parallel, each engine developing the same electrical power, and the three working together as a unit. The Providence makers guaranteed these requirements so fully that they were awarded the contract, and the plant has now been running several months.

The system is one of the most recent examples of long-distance electric railway service at high speed, and some details of it will be of interest.



UNION TRACTION CO. PLANT.

The Union Traction Co. has a mileage of 183 miles, 56 miles of which represent local lines in some cities. It connects the cities and towns of Indianapolis, Muncie, Marion, Elwood and Anderson, Indiana, the power station being located at Anderson, at the junction of three main branches of the sys-

tem. The town of Anderson was chosen for the location of the main power station because of its central position as well as its facilities for the supply of fuel and water. The service given is on one-hour intervals, and is operated on a plan which probably represents as advanced electric interurban practice as can be found anywhere by a road using overhead trolley, approaching very closely to steam road practice in many particulars. For example, in the matter of road bed and right of way, a greater part of the mileage is on the company's own right of way, and it is graded and ballasted after the manner of the most approved steam railroad practice. The population served outside of Indianapolis is about 175,000. The population of Indianapolis is about 170,000.

A line of fast passenger cars has recently been established on this road which makes a run of 53 miles from Indianapolis to Muncie in two hours, easily passing freight trains on parallel steam tracks and giving passenger trains a very close race in the matter of speed.

There are six Babcock & Wilcox boilers with travelling grate stokers for the burning of bituminous coal. The boilers are set two in a battery and each boiler contains 4,000 square feet of heating surface. The headers are of wrought steel, the steam pressure being 155 pounds.

The generating units consist of three horizontal cross-compound Rice & Sargent engines, direct connected to 1,000-kilowatt alternating current generators made by the Westinghouse Electric & Manufacturing Co. The cylinders are 26 inches and 50 inches diameter by 48 inches stroke, and the engines operate at 100 revolutions per minute. The high-pressure cylinders are steam jacketed, and intermediate receivers are placed between high and low pressure cylinders. The massiveness of the fly wheels is noticable and this, combined with the weight of the revolving generator fields, gives a great deal of inertia to the moving parts, which is important in the successful operation of alternators in synchronism on varying loads. The fly wheels are 18 feet diameter and weigh 120,000 lbs. The shaft is 24 inches in diameter in the middle and 22 inches at the bearings, which are 38 inches long. The governor is the Rites, which revolves in a vertical instead of a horizontal plane. To raise or lower the speed for synchronizing a generator with no load upon it, a spring is attached to a lever on the cross-connecting rod, which connects the governor motion of the high and low pressure cylinders. The tension of this spring is adjusted by a small induction motor working a worm gear, the induction motor being controlled by a switch at the switch board, so that the engine speed can be raised or lowered by the switch-board attendant when synchronizing.

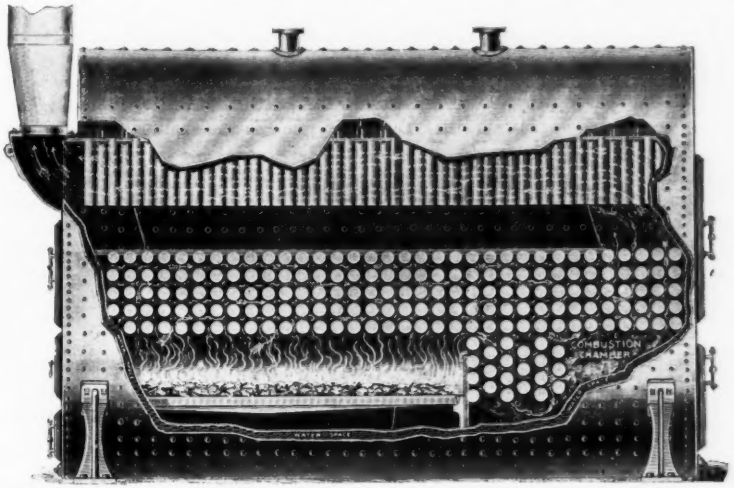
This single power plant with its three Providence engines furnishes the power for the entire system, and is an excellent example of modern engineering.

Kingsley Patent Boiler.

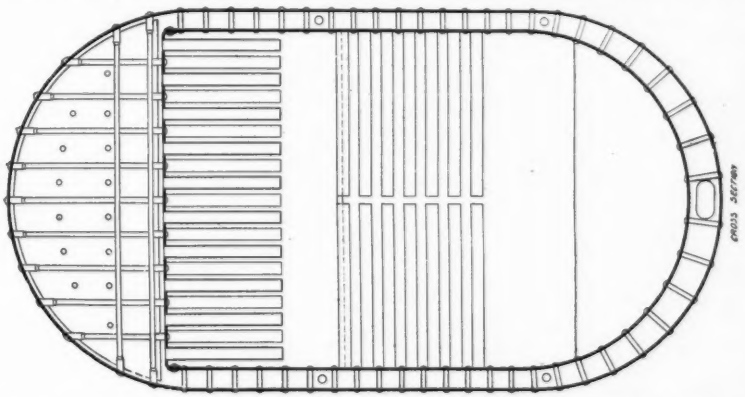
FROM the accompanying cross-section drawings can be gleaned an excellent idea of the interior construction of the Kingsley patent water tube boiler, of the tubulous or pocket tubular type.

In appearance it is a cylinder with flattened sides and consists of an outer and inner shell, the latter—or fire-shell—conforming to the flattened cylinder shape of the outer but having a flat crown sheet and a wider space between the two shells at bottom and above crown sheet than at the two sides. The area between the two shells and surrounding the fire-shell from water level above the crown sheet is the water space. The staying system consists of screw stays, riveted over, between the outer and fire-shell. Excepting in the steam space, there are no longitudinal through stays in the boiler. From each side of the fire-shell, there are a series of blank-ended tubes, the open end of each being screwed through the fire-shell plate into the water space, while its blank, or closed end, extends laterally over and to within a few inches of the longitudinal centre line of furnace, where it is opposed to the corresponding blanked tube from the opposite side. These are named "side" tubes, and from the crown sheet a similar series of blank ended "drop" tubes depend. There is sufficient space between the opposite nests of side tubes to allow room for the removal and replacement of any side tubes without inconvenience and similarly there is sufficient space between the bottom

ends of drop-tubes and the top sides of side-tubes for a like operation. This latter space is also converted into what is practically an extension of the combustion chamber, or vent, by means of a baffle plate or flame director that is secured just above the



top sides of side-tubes and extends—for the full width of the fire-shell—from the front of the boiler to within a calculated distance of the back end; the unscreened space be-



yond this plate forms the combustion chamber, or vent.

With the water level at about 9" above the crown sheet and the fires in operation, the working of this boiler presents novelties which go far to verify and establish its claims for superiority. The side-tubes are enveloped in direct flame and under the baffle plate to the combustion vent at its end. The drop-tubes are exposed to the same conditions in the passage of the heat above the baffle plate to the uptake; with the result that the rapid heating and convection of the isolated columns of water in the side-tubes enforces a very rapid circulation of the water between the shells throughout the area contained between the flattened sides, as the depth of water in cross section at the sides is only about one-third of what it is at the head of the column above the crown sheet and at the bottom, below the ashpit. This rapid and strong

agitation at the middle height of what may be regarded as a water column at each side of fire-shell has the distinct results that the water when leaving a side-tube is practically at the temperature of steam at the working pressure, and readily passes in its course through the drop tubes into steam which is practically dry. The high temperature obtained in the side-tubes free any impurities that the water may hold in suspension. The rapid circulation thus induced effectively scours the tubes and forces any solid particles to a zone below the ash-pit, where it can be cleared by the blow-down, or cleaned from the bottom mud-doors and man-hole.

A boiler of this type now in use in the shipyard of the Townsend & Downey Co., Shooters Island, New York City, has been run continuously for seven months and at the end of that time was found to be as clean and free from scale as when first installed; although each of the two common return-flue boilers with which it was connected in battery are both out of use owing to excessive scale resulting from unusually bad feed water. This Kingsley boiler is alleged to be steadily developing 370 B. H. P. on a coal consumption of less than what the other two boilers in the battery required to develop 160 B. H. P. Its over-all dimensions are 5′ wide x 14′ long x 12′ high, which means an effective evaporation equivalent—in round figures—to 5 B. H. P. per hour per square foot of foundation surface.

Steam is stated to be raised from cold surfaces to full working pressure in 17 minutes with natural draft, and in 12 minutes when forced draft is used.

Among the chief advantages may be enumerated the fact that no bricks or built setting is required, the boiler being ready for steam when landed and connected in place. Extremely dry steam is made. The boilers cannot scale or "foam" with the worst feed water and under the hardest firing. Has no through tubes or stays to be damaged under any usage. Will absolutely develop 1 B. H. P. for each 5 square feet of heating surface. Every unit of heat developed on the fire grate comes into direct contact with efficient heating surface throughout the entire passage from grate to uptake. They are durable and absolutely safe; as a tube would be the first part to suffer damage, and a burst tube would drown out the fire. Any tube can be taken out and replaced within 15 minutes.

Double Compression Coupling.

THE accompanying cut shows a new "Davis" shaft coupling intended for the larger sizes of shafting, where a great amount of power is transmitted and is intended for line shafting from 3 to 8 inches in diameter.

The coupling proper is a rim with three arms supporting the hub, which is turned tapering and cut in three equal parts. There are four compression flanges bored the same taper and fitting the tapering hub. The coupling is first put on the two pieces of shaft, each shaft being pushed into the cen-

ter of the hub. The first two compression flanges are drawn up securely by three bolts. The two outside flanges are then drawn on by three bolts running through the four flanges but drawing only the two outside flanges, thereby securing a very powerful compression, sufficient to drive any line shaft for which they are intended.

These couplings have a hub sufficient in thickness to cut a keyway, if desired, which allows the use of a key or feather to be placed in the shaft, where parties using them so desire. One of the features of the "Davis" coupling is the ease with which it is put on the shaft and the perfect alignment secured, as absolute accuracy can be obtained in the running of the shaft. Any slight swing to the shaft can be corrected by tightening the bolts on the high side.

All mechanics will appreciate this feature, as all know a flange coupling cannot be made to run true until it is first keyed on the shaft and then faced. The time fitting the ordinary coupling is often nearly as expensive as the first cost of such couplings, and no fitting whatever is required on this style of compression coupling.

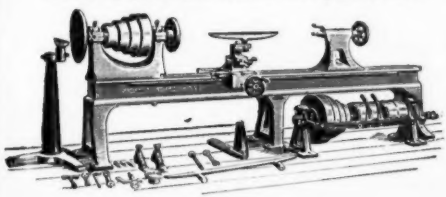
To remove the coupling, the bolts are removed and each of the three bolts are screwed into holes tapped for that purpose in the compression flanges, which forces the flanges off the hub, when the coupling can be slipped off.

The flanges cover the bolt heads and nuts so there is no liability of catching bolts or clothing that may come in contact with them when running.

Manufactured by W. P. Davis Machine Co., Rochester, N. Y.

New Pattern Makers' Lathe.

WE illustrate a new machine, just brought out by J. A. Fay & Egan Co., Cincinnati, O. This new machine, which has an iron bed, will be found invaluable in all wood-working establishments, and pattern shops, and has double face plates, movable carriage rest, foot post and floor stand; it is capable of swinging eighteen to twenty-four inches, and is constructed as strongly as possible.



The spindle is of large diameter, lead ground and fitted with a plate on each end, the outside face plate being clear of the end of the shears, and will allow turning extra large circles. The tail stock is operated by hand wheel and screw, and locked by a hand-wrench, and is absolutely true with the head stock. The movable carriage is gibbed to the shears and supports a cross slide which carries the rest and tool post; it is moved by rack and pinion feed operated by a hand-wheel, and is very useful in turning cylinder patterns and other long material. This machine will be supplied with or without the bed.

The manufacturers will furnish prices and full particulars on application.

An Advertisers Follow-Up System.

THERE has been a great demand for a practical system of following up advertising, which would show both the cost of publicity and the results in inquiries and sales, for ready comparison. This problem seems about to be solved through the use of the "Advertisers Follow-up System" with cost and result record, in the form of a loose leaf book, size 11x16 inches designed and perfected by Frank M. Ho-glen and Clarence P. Day, for the purpose of easily and quickly recording every inquiry and sale produced through publicity, tracing and posting each inquiry and sale to its true source, besides keeping a check on every advertisement and medium, thereby eliminating all theory and guesswork as to the real paying qualities of the mediums used.

The ledger pages of this book give a complete abstract of every advertising contract, with form for checking the amount of space used in each issue, and its cost. Every important detail is carefully recorded, so that instant comparison may be made.

The book is handsomely bound in patent loose leaf covers, has double index and enough ledger pages to last for years. Extra loose sheets may be inserted at any time and the old sheets removed and filed away when completed. The book is made to lay flat.

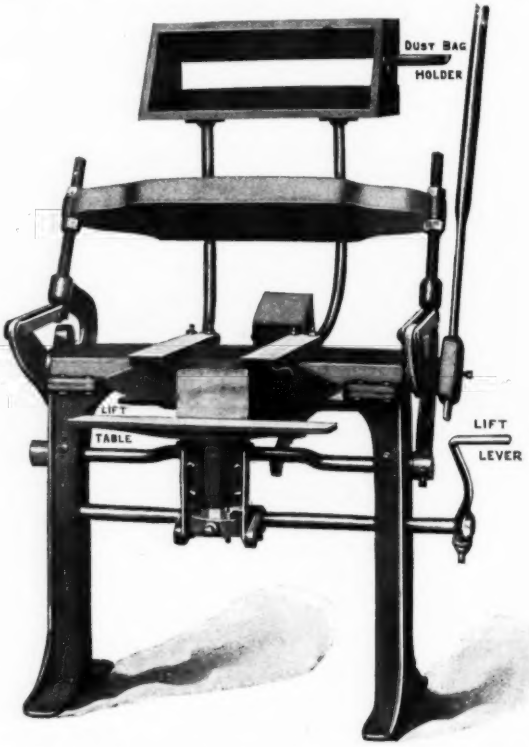
Further information and price may be

had by addressing Ho-glen & Day, Rooms 1,505-7 Nassau-Beekman Building, New York.

Universal Molding Machine.

THE accompanying engraving illustrates a type of the Farwell universal molding machine for foundries, made by The Adams Co., Dubuque, Iowa. This labor-saving device brings highly favorable results in two ways. It provides means by which an experienced man is enabled to do inexperienced men on the machines and in a few days get results that would be impossible without the machines.

The Farwell universal molding machine consists of combining the "squeezer" feature of the plain molding presses with the pattern drawing feature. They can be used either with or without stripping plates. When used with stripping plate, the pattern, which is secured to the frame, rests firmly on the machine table and the stripping plate rests firmly on the pattern frame. It will



the work of a skillful molder and the skillful molder can when he has laid aside his prejudice, greatly increase his day's work.

There is still another advantage in using molding machines in the foundry. When a foundry is dependent upon skill for its molds and the "skill" believes that "In union there is strength," there may be trouble. If trouble comes and this foundry is equipped with molding machines, the foreman can put

here be observed that both pattern and stripping plate do not rest on the lift table, but are firmly supported by the rigid machine table, where they can well withstand the ramming and pressing of the sand, The stripping plate is supplied with studs that extend down and rest on the lift table. When the lift lever is operated the lift tables are raised, thus raising the stripping plate and drawing the pattern.

When this feature is used without the stripping plate, it is called the "lift off" method. These patterns like stripping plate patterns are necessarily in two sets, one for copes and the other for drags, unless the work is of the symmetrical type and both copes and drags can be made from the same half pattern. The half patterns are secured to a plate. Studs resting on the lift tables extend up and pass loosely through the pattern plate and engage with the flask. When the lift lever is operated and the lift tables raised, the flask is lifted off the pattern.

An excellent way to run small flasks is to press the sand and draw the pattern in both cope and drag, side by side, in one operation.

Industrial Notes.

—The Pratt & Whitney Co., manufacturers of machine tools, who have offices in New York, Boston, Chicago, Buffalo and Philadelphia, have completed arrangements to open a sixth branch in Pittsburg, in the new Frick building. Mr. D. L. Macomber will take charge of the new office.

—Messrs. Jno. Martin & Co., Pacific Coast Representatives of the Stanley Electric Mfg. Company, of Pittsfield, Mass., have opened an office in the Douglas Building, Third and Spring Streets, Los Angeles. The Jno. Martin & Co. already have offices at San Francisco, and Seattle, Wash.

—The Pelton Water Wheel Company, whose New York offices are at 136 Liberty street, is reported to have recently secured orders for three 300 horse-power water wheel equipments, to be used for electric transmission by the Hilo Electric Power & Refrigerating Company of Hilo, Hawaiian Islands. An order for a 300 horse-power outfit has been obtained from a Japanese silk mill, and a 200 horse-power air compressor plant has been requisitioned for by British Columbia parties.

—Mr. O. G. Smith, who has been in the office of the air compressor department of the Stilwell-Bierce & Smith-Vaile Co., of Dayton, Ohio, has recently succeeded Mr. P. B. Fenlon, as manager of the Philadelphia office at No. 612 Arch street. The company has also secured the services in the sales department of Mr. A. L. McClurg, who for the past six years has been in the employ of the Harrison Safety Boiler Works. Mr. McClurg will work in connection with the Pittsburg sales-agent, Mr. E. F. Austin.

—Owing to the rapid increase in the business from year to year, the Keystone Drop Forge Co., of Germantown Junction, Philadelphia, have found their present plant totally inadequate to the natural increase in the future and have purchased a large plot of ground in Chester, on the banks of the Delaware river. The new site has abundant railroad facilities. Several new buildings will be erected. They will be designed and equipped with all the modern appurtenances necessary for their line of business. Work on the improvements will begin immediately.

—The Buffalo Forge Company, of Buffalo, N. Y., are building a large and interesting fan to be used for mine ventilation by the Modoc Coal Mining Company, of Gloucester, Ohio. This fan is an immense o... with a 250-inch housing of the three-quarter type, and is constructed throughout of steel plate rigidly stiffened and braced. The blast wheel or rotating element of the fan is of special design. It is to be driven by a direct connected horizontal engine at a speed in the neighborhood of 150 revolutions per minute. The fan will deliver 125,000 cubic feet of air per minute at ordinary working speed. This is one of many typical mine ventilating plants which are constantly being built and installed by this company.

—The month of March has brought to the Crocker-Wheeler company orders for eleven more motors to be added to its already large equipment in the new Philadelphia Mint. This brings the total number furnished to 120, besides four generators aggregating 625 K. W. Nearly the entire installation is of Crocker-Wheeler manufacture and the plant is most interesting in the completeness of the distribution of power by electricity. In fact, the metal is electrically treated from the time it enters the building until it leaves it. The electric current refines it, the rough ingot is topped, rolled, cut and weighed all in motor driven machines, an acid bath then leaves it ready

for the coining machines which are a unique application of a small motor driving a large fly wheel of sufficient momentum to insure a heavy pressure at the instant of stamping. The whole plant demonstrates the extent to which electric operation may be successfully carried.

—The Iroquois Machine Co. has just been incorporated, having been organized by Mr. W. W. Gibbs, who is also vice-president of the Kidder Press Co. and a member of Gibbs-Brower Co., of New York. The officers are Edwin A. Smith, president, who is a prominent banker in Providence, R. I.; W. W. Gibbs, vice-president and general manager, New York; Henry C. Babcock, secretary and treasurer, Providence, R. I. Principal office, New York. The company will manufacture new and improved wire drawing machinery, which they claim will materially reduce the cost of producing wire. They will also manufacture a full line of automatic and plain drop hammers, swaging machines, rolling mills, roller bearings and grinding machines. Having ample capital, they have purchased the plant and business of the Universal Machine Co., located at Providence, and rented a large additional building adjacent to the same. The purchase of this running plant, and the addition named, will insure to their customers prompt filling of their orders. We understand they will erect a new factory building during the coming summer.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firm issuing them. Please mention The Engineering Magazine when you write.

Arch Plate.

Small booklet, treating the Lamprey protective arch plate, for use with all types of boilers. Testimonials. The Lamprey Company, 97-103 Cedar street, New York City.

Asphalt Roofing.

Booklet on the latest type of asphalt roofing ready for laying. Instructions for using. Claimed to be superior to metal and all other types of composition roofing. Asphalt Ready Roofing Co., 136 Water street, New York.

Astronomical Instrument.

Attractive pamphlet entitled "Instruments for Astronomical Observatories." Warner & Swasey, Cleveland, Ohio.

Belt Dressing.

A very short booklet showing how the efficiency of belts may be increased two-fold with terse description of the preparation. Sure Grip Manufacturing Co., Station G, Philadelphia.

Blowers.

Illustrated Catalogue No. 134, showing "A B C" steel plate fans for heating, ventilating and drying plants, forced and induced draft apparatus, etc. Also a two-sheet folder, illustrated, on the Morehead return trap. American Blower Company, Detroit, Mich.

Bolt Cutters.

A series of folders treating separately, in the several sizes, the Morgan patent bolt cutters, with full description of the machine parts. Uniformity of production, durability and simplicity claimed. The Reliance Machine & Tool Co., Cleveland, Ohio.

Book Typewriter.

Handsomely published catalogue on the Elliott book typewriter; also a short sketch on the subject of manifolding. The machine is an excellent labor-saving device in offices where a large amount of billing is necessary. Facsimiles of testimonials. The Elliott & Hatch Book Typewriting Co., 256 Broadway, New York City.

Carbonizing Coating.

Booklet illustrating the advantages of using "Carbonizing Coating" on modern steel structures. Prevents rust and corrosion. Testimonials. The Goheen Mfg. Co., Canton, Ohio.

Car Couplers

Pamphlet illustrating by photograph and detailed drawings, the Washburn coupler for freight and passenger cars, tenders and pilots, with and without flexible heads. Size, 49 pages, 6 by 9 inches. The Washburn Coupler Company, Minneapolis, Minn.

Cement Plants.

Very handsome volume, bound in cloth, treating the design and construction of complete cement plants. Published in English, German and French. Exhaustive treatise on the development of the industry in this country. The section devoted to the design and the construction of the plants is profusely illustrated. Lathbury & Spackman, Philadelphia.

Circuit Breaker.

A handsome and ingeniously-arranged catalogue of the "I-T-E" circuit breaker, printed in four languages, viz., English, French, German and Spanish, in parallel columns. Describes the properties which overcome overloads or excessive currents, cessation of line pressure or voltage, diminuation or cessation of current, reversal of the direction of the flow of current, and the occurrence of predetermined mechanical conditions, either singly or in any combination. The Cutter Co., Nineteenth and Hamilton streets, Philadelphia.

Commutator Brush.

Attractive booklet on the fibre-graphite noiseless, self-lubricating brush. Of especial value in isolated plants. Revised price lists. Holmes Fibre-Graphite Manufacturing Co., No. 5155 Wakefield street, Philadelphia.

Core Drilling.

Catalogue entitled "Core Drilling Without Diamonds." Brief historical sketch setting forth how the system of core drilling without the use of diamonds, thus reducing the cost of the machine, was perfected. Illustrations and full descriptions of the drill and parts. Davis Calyx Drill Co., 128 Broadway, New York City.

Counting Machine.

Small, prettily designed booklet setting forth the Durant counting machine. W. N. Durant, 237 Twenty-second street, Milwaukee, Wis.

Drills.

Circular No. 43 "A" treating mining, tunneling and quarrying machinery. Very well illustrated, showing the machines in actual use. Instructive treatise on modern quarry methods. The Ingersoll-Sergeant Drill Co., 26 Cortlandt street, New York City.

Drill Presses

Illustrated catalogue "F," showing an extensive line of drill presses and chucks, wire straighteners and cutters, bicycle machinery, and furniture and bed spring machinery. Size, 40 pages, 6 by 9 inches. Hoefer Manufacturing Company, Freeport, Ill.

Electric Hoists.

Illustrated pamphlet No. 0115, on the "Hunt" electric hoists. Tables of sizes and capacities. Full description of the machine parts. C. W. Hunt Co., West New Brighton, Staten Island, N. Y.

Electric Lamps.

Booklet, treating briefly the Sterling electric incandescent lamp. Sectional drawings of all types of incandescent lamps showing the unequal distribution of light, and the perfect distribution of the full candle power by the "Sterling." The Sterling Electrical Manufacturing Company, Warren, Ohio.

Electric Transformers.

Bulletin No. 8, illustrated, entitled the "Ultimate Efficiency of Transformers." The subject is treated in a clear and concise manner, setting forth its efficiency and substantial construction. Some radical advances made in the construction of the transformers recently. Pittsbury Transformer Co., Pittsburg, Pa.

Engines.

An attractive catalogue illustrating and describing the latest types of mining, marine and stationary engines, with complete price lists. The Marine Iron Co., Second and Water streets, Bay City, Mich.

Engines, Direct Connected.

Bulletin No. 100, illustrating the "Racine" vertical, automatic engines direct connected with a number of well known generators, for use expressly in lighting, storage battery and power service plants. Racine Hardware Co., Racine, Wisconsin.

Engineering Specialties.

Small booklet, profusely illustrated, treating the Curtis engineering specialties for the regulation and control of any pressure of any fluid at any temperature for any purpose, and under all conditions. Julian D'Este Company, 24 Canal street, Boston, Mass.

Feed-Water Heaters.

Catalogue No. 41, setting forth the advantages of the present feed-water heater over the antiquated forms of steam making. Combined table of dimensions with code. The Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio.

Filter Presses.

Very attractive, new catalogue treating the Johnson filter-press; also, the broader lines generally found to be the most practicable in operating any filter-press system. John Johnson & Co., No. 1 Franklin Square, New York.

Foundry Supplies.

Small, compact catalogue No. 10, with complete lists of foundry facings, and blackings, and all supplies for the equipment of iron and brass foundries. J. D. Smith Foundry Supply Co., Cleveland, Ohio.

Gas Engines.

Very attractive catalogue, replete with illustrations, treating the Bogart gas engines, types "A," "B," "C," and "D," for both light and heavy duty. Explanation of the more vital machine parts. Farrar & Trefts, Buffalo, N. Y.

Hammers.

Catalogue issued in 1901, profusely illustrated in natural colors, showing the various styles and sizes of the Maydole hammers. Price lists; indexed. The David Maydole Hammer Co., Norwich, Chenango County, N. Y.

Hoisting Engines.

Catalogue "G," fully illustrated, treating portable and semi-portable steam hoisting engines, geared locomotives, derrick cars, and irons, hand powers, blocks and sheaves. Of exceptional interest to contractors and quarrymen. Full tables of specifications. The John F. Byers Machine Co., Ravenna, Ohio.

Hydraulic Engines.

A very attractively gotten up catalogue, profusely illustrated, demonstrating the capacity and simplicity of the "Niagara" hydraulic engine, and giving testimonials of its merits. The Niagara Hydraulic Engine Co., Chester, Pa.

Insulation.

Export lists, in either English or Spanish, of all grades of Habirshaw insulated conductors or cables for both lined and unlined conduits. The India Rubber and Gutta Percha Insulating Co., Yonkers, N. Y.

Locomotives.

Catalogue No. 32 (1902) entitled "Seventy Years of Locomotive Building," describing the work and progress in engine building from the construction of "Old Ironsides" down to the present time. Of exceptional interest to railroad men. Baldwin Locomotive Works, Philadelphia.

Machine Tools.

1902 Catalogue, showing complete line of high grade machine tools; indexed; telegraphic code. Contains full description with speed tables of all types of heavy and light milling machinery; information of exceptional interest to works managers and foremen. Brown & Sharpe Mfg. Co., Providence, R. I.

Milling Machines.

Illustrated folder showing a milling machine especially designed for rapidly handling work requiring only short cuts. The Kempsmith Mfg. Co., Milwaukee, Wis.

Mining Machinery.

Catalogue No. 8(sixth edition), substantially published, with index and illustrations and sectional drawings of the various types of crushers, rolls and pulverizers. Allis-Chalmers Co., Chicago, Ill.

Motors, Electric.

Very handsome, profusely illustrated catalogue containing a number of cross-section drawings, showing the small motor at work as a machine driver. General Electric Co., Schenectady, N. Y.

Nautical Instruments.

Illustrated catalogue of all kinds of nautical instruments and instruments of navigation. Also booklet entitled "Of Interest to Navigators," treating the same subjects. Riggs & Brother, 310 Market street, Philadelphia.

Perforated Metals.

Very handsome presentation of catalogue No. 7 (ninth edition), showing illustrations, with descriptions of all the latest patterns in perforated metals. Indexed; telegraphic code. Allis-Chalmers Co., Chicago, Ill.

Portland Cement.

Small, profusely illustrated booklet showing work of all classes done with Owl cement. Testimonials. German-American Portland Cement Works, Marquette Bldg., Chicago, Ill.

Power Pumping Machinery.

Catalogue No. 40, indexed, with tables of sizes, capacities, and code words, of all types of power pumps for every usage. Fully illustrated. The Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio.

Prospecting Machinery.

Exceedingly attractive catalogue No. 2 (1902) on the subject of drilling machines. A treatise on placer mining, illustrated. Indexed. The Keystone Driller Co., Beaver Falls, Pa.

Pumps.

Catalogue "A," substantially bound, showing every kind of pump manufactured. Tables of sizes and prices. Indexed. The Goulds Manufacturing Company, Seneca Falls, N. Y.

Railway Materials.

Small attractive pamphlet, entitled: "A Short Railway Story." Treatise on narrow-guage railway materials. Also gives a general idea of the varied products manufactured. Of special value to those interested in narrow-gauge equipment for mines or industrial plants. Arthur Koppel, New York.

Rolling-Mill Machines.

Catalogue for 1902, illustrated, showing all manner of milling machines from the smallest to the largest type. Indexed; tables of sizes and telegraphic code. Blake & Johnson, Waterbury, Conn.

Rope Transmission.

A very attractive booklet entitled "A Little Blue Book on Rope Transmission." The subject is treated scientifically, fully demonstrating the good results attained from rope-driving. Profusely illustrated. The American Mfg. Co., 63 Wall street, New York.

Safety Lifts.

Illustrated booklet on the Burr automatic safety lifts. Tables of size and capacity. Testimonials. The Burr Mfg. Co., Cleveland, Ohio.

Saw Mill Machinery.

Catalogue in Russian, well illustrated, showing all types of saw mill machinery. A. B. Farquhar, New York.

Saw-Mill Specialties.

Small, conveniently arranged catalogue, treating all styles of saws and saw mill specialties. Complete price lists. Most convenient for mill owners and operators, and contractors. The James Ohlen & Sons Saw Manufacturing Company, Columbus, O.

Seamless Tubing.

Illustrated pamphlet demonstrating the process of manufacture and the uses of the "Benedict-Nickel" seamless tubing Complete tables of sizes and prices. Practically indestructible. Benedict & Burnham Manufacturing Company, Waterbury, Conn.

Smelting Furnaces.

January Catalogue (1902), third edition, showing the advantages of the Vulcan furnace for the treatment of ores. Equally successful with all kinds of ores. Vulcan Smelting and Refining Co., San Francisco, Cal.

Steam Engines.

Catalogue showing all types of simple and compound engines. Profusely illustrated. Tables of specifications. Also all types of stationary and portable water tube boilers. Harron, Rickard & McCone, 21 and 23 Fremont street, San Francisco, Cal.

Steam Shovels.

Catalogues Nos. 12 and 13, substantially bound in leather, treating all manner of steam shovels for dredge work, loading and unloading cars, placer mining, etc. Contains tables showing capacity. Full page illustrations showing machines at work. The Marion Steam Shovel Company, Marion, O.

Steam Superheater.

Very substantial catalogue on the Schmidt system of utilizing highly superheated steam. Handsomely illustrated and containing information of the highest value to mechanical engineers. Providence Engineerings Works, Providence, R. I.

Steam Traps.

Small, compact booklet with external and cross-section views of the "Direct

Separator" steam trap with full description of the workings. Also tables of sizes, capacity and prices. The Direct Separator Co., Syracuse, N. Y.

Steel Castings.

Attractive pamphlet, compactly gotten out, by manufacturers of high grade crucible steel tools, made without forging on short order. New process. Uniform Steel Co., Newark, N. J.

Steel Hardening.

Booklet demonstrating the refining qualities and inexpensive "Carbo-Mangan" process of steel-hardening. Concise; illustrated. The Carbo-Mangan Company, Nyack, N. Y.

Superheater.

Folder on superheated steam and its properties, a few types of superheaters, with practical demonstrations of the value of the method, and the thermodynamics of the subject. Tables of comparison. The superheater as a money-saving device. Power Specialty Co., 126 Liberty street, New York City.

Trench Braces.

Catalogue "D" (1902) showing a complete line of extensible trench braces, for use in all excavation work. Profusely illustrated. Dunn Mfg. Co., Pittsburg, Pa.

Tools

Catalogue No. 115, of tools for machinists and metal workers, showing a most extensive line. This house deals with customers direct, and not through the trade. Size, 300 pages, 5½ by 7½ inches, cloth bound. Hammacher, Schlemmer & Co., New York.

Valves

A comprehensive catalogue, presenting a line of flanged fittings and gate valves for 125 pounds working pressure. The new dimension tables are much simpler than those heretofore given. Crane Co., Chicago, Ill.

Small catalogue of Bashlin valves, with renewable working parts, disc and seat ring, the latter admitting of charge while the valve is under pressure. Size, 16 pages, 3½ by 6 inches. The Bashlin Co., Warren, Pa.

Vertical Engines.

Substantial catalogue, containing complete tables of capacity and general dimensions of vertical and horizontal engines. All sizes and styles. Quincy Engine Works, Quincy, Ill.

Water-Tube Boiler.

Catalogue entitled "An American Invention." A water-tube boiler constructed without bricks. Economical and safe. The Kingsley Patent Boiler Co., 30 Broad street, New York City.

A very handsome catalogue, showing the Babcock & Wilcox boiler installed in the merchant marine and in ships of the United States and foreign navies. Many striking and most interesting views of vessels adorn the book. Size, 176 pages, 8 by 10½ inches. Cloth binding. Babcock & Wilcox Co., New York.

Water-Wheel Governors.

Catalogue entitled "Speed Regulation of Water Power Plants." It is claimed the Sturgess governor combines the qualities of close speed regulation, reliability and endurance, simplicity, adaptability to all kinds of plants, low first-cost and maintenance. Sturgess Governor Engineering Co., Troy, N. Y.

Wire Specialties.

Illustrated booklet on iron and steel wire, steel springs and all kinds of wire specialties. Tables of sizes, weights and prices. Morgan Spring Co., Barbers Crossing, Worcester, Mass.

Wood-Working Machinery.

New combined catalogue, replacing separate catalogues for the two firm departments, contains descriptions of new and improved machines. Valuable to all woodworkers. Enables buyers to gain an adequate idea of the many diversified lines of machines. J. A. Fay & Egan Co., Cincinnati, Ohio.

Yachts, Naphtha and Steam.

A handsome booklet, describing at length the advantages of naphtha and steam yachts as craft for business, health or pleasure. Touching casually on all maritime craft. Useful to persons contemplating the purchase of any kind of boat of light draught. Complete price lists. Gas Engine & Power Company and Charles L. Seabury & Co. (Consolidated), New York.